Vol. XVII No. 1, 19

Man and Environment

Archaeo

CUK-H06257-4-KP2047

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Indian Society for Prehistoric and Quaternary Studies

Man and Environment

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Man and Environment is published bi-annually in June and December. It publishes original research papers, review articles, short research reports, and book reviews. The scope of the Journal covers prehistoric societies and all aspects of their environment, as well as contemporary environment and simple societies with a relevance to the past.

Contributions to the Journal should be sent to V.N. Misra c/o Department of Archaeology, Deccan College, Pune 411 006, India. The packet containing the manuscript should be superscribed "For Man and Environment". The authors should carefully follow the Guidelines for Contributors printed in *Man and Environment*, Volume XIII. They can also ask for a copy of the Guidelines from the Editor.

All articles submitted for publication will be refereed. Authors will be asked to revise their manuscripts in the light of referees' comments. Acceptance of the manuscripts will mainly depend on the approval of the referees.

Authors will get 25 reprints of their paper gratis. They can order additional reprints at cost price on a prescribed form which will be sent to them along with the letter of acceptance of their manuscript.

The Journal is distributed from the office of the Society at Pune only to Life Members of the Society. Non-members, Institutions and Libraries should place their orders directly with the Distributors at Delhi.

Publisher: Indian Society for Prehistoric and Quaternary Studies
c/o Department of Archaeology, Deccan College,
Pune 411 006, India

Printers: Mudra
383 Narayan Peth
Pune 411 030

Distributors: Books & Books
C4A/20 A, Janakpuri
New Delhi 110 058

Price: Rs. 300.00

Editorial

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This issue of the Journal continues the pattern of publishing multidisciplinary and a broad spectrum range of articles reflecting the varied aspects of ongoing research in Indian archaeology. M. Kasturi Bai reports new prehistoric and protohistoric finds from the Eleru Basin in Andhra Pradesh. V.S. Shinde discusses finds from his second season's excavation at Padri in Gujarat. For too long the picture of the Indus civilization has been biased in favour of large urban settlements. Small and short-lived rural sites like Padri now provide the much needed corrective to give a balanced picture of the settlement pattern of this civilization. V.S. Pathak's note on the human figure on the painted jar reported from Padri in the previous issue of the Journal attempts to explain the figure in the perspective of the sacrificial ritual symbolism of the *Rigveda*. It provides an interface between literary tradition and archaeology and will, hopefully provoke interesting discussions.

The paper of M.K. Dhavalikar and G.L. Possehl assesses the cultural and chronological position of Prabhas Patan in Gujarat, excavated many years ago, against the background of other recently excavated sites in the region. P.C. Venkatasubbaiah reports new faunal material from the Neolithic sites of Cuddapah District. Vinod Nautiyal discusses results of the phosphate analysis of soils from certain burial sites in the Kumaon region in the Garhwal Himalayas. A.S.A. Lateef's article attempts to reconstruct the palaeoenvironment of the Zagros foothill region in Iraq on the basis of the study of conglomerate deposits. S.B. Ota files an exploration report on the area threatened with submergence by the controversial Narmada Sagar Dam in Madhya Pradesh. R.V. Karanth, an authority on gemstones, with a rich personal collection of such stones, discusses techniques of gemstone cutting and the ancient gemstone industry in Cambay.

In addition, the Journal carries B.B. Lal's Presidential Address delivered at the Annual Conference of the Society at Bhopal in December 1991. He draws attention to the lack of popular literature on Indian archaeology and emphasizes the archaeologists' obligation to share the results of their research with the educated public. He has made a forceful plea to the Society to publish 50 popular books on archaeology to coincide with the fiftieth anniversary of India's Independence in 1997. He has also provided a tentative list of the titles. His plea is receiving due attention from the Society. Rajam Seshadri's article, which was selected for the first Professor H.D. Sankalia Memorial Young Archaeologist Award and was presented at the Annual Conference at Bhopal is also published in this issue.

A complete list of the Society's Life Members has, since Volume XIII, been published each year in the June issue of the Journal. However, we find that as the list is becoming longer every year, its printing also increases the cost of publication. We have therefore decided that from this issue onwards, we will only publish the addresses of new members and changes in the addresses of old members.

It has come to our notice that some authors have submited to *Man and Environment* the same manuscript they have sent to another journal, so that it is published in more than one place. This is an unethical practice, and it certainly circumvents our policy of publishing only original manuscripts. In future we will consider only those manuscripts which are accompanied by an explicit declaration that the manuscript has not been and will not be submitted to another journal until our decision on whether we will publish it or not has been received by the author.

We have regularly requested the Society's members to communicate to us changes in their addresses without delay but unfortunately our request is not always heeded. We receive a large number of complaints from members about the non-receipt of the Journal. In at least some cases this happens because the members have not communicated to us their new addresses and the Journal has been despatched to the old address. To ensure safe delivery the Journal is despatched under Certificate of Posting. To send a second copy of the Journal to a large number of members is an unnecessary drain on the Society's finances. It will not be possible for us to replace the missing copy in case of members who fail to promptly communicate the changed address to us.

We Archaeologists and Society

B.B. Lal

Former Director General
Archaeological Survey of India
Purana Qila
New Delhi

In Presidential Addresses like the present one it has generally been the practice either to summarise the salient achievements in the discipline since the last meeting of the Society or to take up a topic on which one has specially been working and to put forward one's considered opinion in the matter. However, I beg your pardon for making a complete departure from the aforesaid practice and placing before you some thoughts on 'We Archaeologists and Society'.

Since Independence archaeologists in India have made great strides. This is not bragging but a cold statement of fact. Perhaps it is a case of illustrating the old proverb which, slightly modified, would run: 'Necessity is the mother of discoveries'. For example, with the passing over of the Potwar region to Pakistan at the time of Partition, we on the Indian side of the border, were left with hardly any sites of the Soanian Pebble-tool Culture. But efforts have brought to light a number of sites of this culture, such as Guler, Dera Gopipur, etc. As we all know, this may be the earliest Stone Age industry on our Subcontinent. And yet, have we done anything to pass the information on to the average intelligent Indian?

At one point of time it was held that there was a great hiatus between the Palaeolithic and Mesolithic stages in India. Sustained efforts have brought to light evidence from various parts of the country showing that indeed there was no such hiatus. We have now an almost continuous story from the Lower Palaeolithic times right up to the Mesolithic. The evidence shows a gradual evolution, with some new cultural features emerging at every stage. We have excellent data concerning the Mesolithic folks from sites like Birbhanpur, Sarai Nahar Rai, Damdama, Mahadaha, Adamgarh, Bagor, Patne, Sangankallu, etc. We now have an idea not only of how these Mesolithic people lived, but also of how they disposed of their dead. In fact, the occurrence, in some graves, of two bodies, a male and a female, raises some interesting sociological questions. Were such burials the result of the two persons having died more or less simultaneously just by chance, or does one have to see in these burials what has been visualized as evidence for the practice of *Sati*, as in the case of the double burials at the Harappan site of Lothal?

Continuing with the Stone Age, perhaps the single most important achievement since Independence is the discovery of Bhimbetka which unfolds an almost continuous story right from Palaeolithic times. But what is significant about Bhimbetka is that, besides the Stone Age habitats and tools, we have here the most remarkable paintings. The discoverer of these paintings, Dr. V.S. Wakankar, alas, is with us no more. He was an indefatigable explorer, with few, if any, to match his perseverance and insight. These paintings, with a rich variety of colours as well themes and exhuding vivacity and supreme artistry, can very well be compared with any other large group of prehistoric paintings anywhere in the world — be it that of Lascaux in France or of Altamira in Spain. A few books, burdened with technical details, have no doubt been published on the Bhimbetka paintings. But have we ever thought that this great heritage of ours needs to be brought to the notice of the layman who, I am sure, will not only rejoice at the beauty of these paintings but will also take pride in the fact that he is the owner of this great heritage?

The work in the cold clime of Kashmir has opened up new vistas in the valley, not even dreamt of prior to Independence. At Burzahom near Srinagar we have the evidence of a Neolithic settlement dating back to the early third millennium B.C. Even its earlier stages, in the form of a pre-pottery Neolithic, have been discovered at Gufkral. Evidently because of the cold climate these people lived in partly or largely underground pit-houses. Excavations at the site of Karuo, located on a 3100 metre high plateau in Tibet have brought to light pottery and stone and bone tools exactly similar to those from Burzahom. Do our people

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Presidential Address delivered at the XIX Annual Conference of the Indian Society for Prehistoric and Quaternary Studies, Bhopal, December 16-18, 1991.

know that our contacts with Tibet are as old as five thousand years?

When we pass on from prehistory to what is known as protohistory we can take pride in three major achievements. These lie: (i) in the realm of the Indus Civilization; (ii) in the blotting out of the epithet, *terra incognita* from central India and northern Deccan; and (iii) in providing evidence that after all the two Indian epics, the *Mahabharata* and the *Ramayana* may not be figments of the imagination, as some scholars are prone to believe, but may well contain a kernel of truth.

Let us look at the Indus Civilization first. After Partition only two small sites of this civilization were left on the Indian side of the border, Kotla Nihang in the Punjab and Rangpur in Gujarat. In fact, doubts were expressed about even these two sites. Indian archaeologists, however, did not lose courage. Instead, they took up the challenge and have by now discovered over 800 sites, belonging to the various stages of this civilization, some even antedating it. This number, it may be observed, is more than the number of sites recorded in Pakistan. However, it is not just the number that matters, but the tremendous amount of new information that the Indian sites have added to our knowledge of the Indus Civilization. To be brief, I will consider here the main contribution of only three sites, Kalibangan in Rajasthan and Lothal and Dholavira in Gujarat.

At Kalibangan we have what may be the earliest ploughed agricultural field in the world, brought to light by means of an excavation. It is associated with a cultural horizon which antedated the Indus Civilization and may thus go back to the first quarter of the third millennium B.C. It is characterized by a criss-cross pattern of furrow-marks, indicating that two types of crops were raised simultaneously in the same field. These may have been mustard and horse-gram. But what is still more exciting is the fact that this gridiron pattern of ploughing fields has withstood the test of time and may be seen even today in rural Punjab, Haryana, northern Rajasthan and western Uttar Pradesh.

Kalibangan has given evidence of another 'the earliest'. Around 2600 B.C. the pre-Harappan settlement was struck by a severe earthquake, as a result of which the site had to be abandoned. Ruptured walls and sunken strata, noticed at many spots at the site, tell this story very vividly.

Lothal can boast of the earliest dockyard in the world. Evidence regarding sea-borne trade between India and Iraq, via the Persian Gulf, was well known, but the existence of a regular dockyard from where small coastal ships sailed westwards and back, carrying a variety of cargo, came to light only in the 50s. The dockyard was located along the eastern edge of the town and had a wall of kiln-fired bricks around it. It was connected, by a specially dug channel, with the Bhogava river which in turn joined the Sabarmati, the last-named emptying itself into the Gulf of Cambay. Riding on high tides, the boats came up to the dockyard, rested in the basin for unloading and loading, and then sailed back to the sea through the same route at the time of a subsequent low tide. The site has also yielded the remains of a warehouse close to the dockyard, where incoming and outgoing goods could be temporarily lodged. An inadvertent fire, no doubt bad for the Lothalians but a boon to archaeologists, destroyed the warehouse, but left behind a large number of sealings bearing impressions of reeds, cloth and thread used in the packages, as well as evidence of the Indus inscriptions which authenticated the goods.

The usual pattern of town planning of the Indus people was to have two segments, a so-called 'Citadel' on the west and a 'Lower Town' on the east. Dholavira, currently under excavation, has shown a more elaborate form of town planning. The settlement has three contiguous parts, all fortified — a Citadel, a Middle Town and a Lower Town. From the architectural point of view, its massive stone work has no parallels, but what is more interesting is the presence of stone blocks and with pillars with very fine polish resembles that on Asokan pillars which indeed, if these had not been found *in situ*, scholars would have doubted their antiquity, dragging them down from the third millennium B.C. to the third century B.C.

We are familiar with seals and sealings bearing Indus inscriptions. But the discovery of an inscription nearly 3 metres in length was never heard of. There are 9 signs in the inscription, each measuring about 37 cm in height. What a colossus!

But, to revert to my agony. Have we brought these marvellous discoveries relating to the Indus Civilization to the notice of our people? In fact, even today the textbooks for children continue to speak of Harappa and Mohenjo-daro, now in Pakistan, as the only Indus settlements worth the name, but rarely, if ever, are Kalibangan, Lothal and Dholavira mentioned. Who is responsible for this communication gap? Surely, we archaeologists and none else.

For a very long time it was held that settlements in central India and northern Deccan did not go back prior to the early historical times. But concerted efforts have brought to light sites like Eran, Maheshwar, Navdatoli, Inamgaon, Daimabad, etc., which have clearly demonstrated that there were regular and sizeable settlements in these regions in the second millennium B.C., in some cases even earlier. The multi-disciplinary approach used in the excavations at Inamgaon is a model of its kind. It has helped to bring to light facts which would otherwise have been lost had the excavations been undertaken in the manner of Harappa or Mohenjo-daro. We have come a long way in our techniques of excavation, recording and analytical studies and, although there is always scope to learn, experiment and improve, we in India need not feel small before our counterparts in the rest of the world.

From Daimabad also come four large-sized bronzes: a bullock-drawn chariot with its charioteer, a buffalo, a rhinoceros and an elephant, together weighing as much as 65 kilograms. Although not found in a regular excavation, these figures seem to belong to one of the protohistoric phases of Daimabad. Indeed, Indo-Pakistan archaeology has no parallels for these virile and massive art objects which may date back to about 2000 B.C.

At the time of Independence, in northern India a wide archaeological gap between the end of the Indus Civilization and the early historical period stared us in the face. It was felt that there was something like a 'Dark Age', covering approximately a millennium. Persistent efforts have satisfactorily bridged this gap, first by bringing to light the Painted Grey Ware (PGW) Culture which well preceded the Northern Black Polished (NBP) Ware and then by establishing, at sites like Bhagwanpura, that the PGW Culture overlapped with a cultural phase representing an amalgam of a diluted late Harappan Culture and other post-Harappan elements. The enigmatic Copper Hoards of the Ganga basin, which were floating in the air, have since been assigned their chronological horizon, broadly in the second millennium B.C.

Dealing with another aspect of the so-called 'Dark-Age', it has been possible to ascertain that, after all, there may be a historical base, however attenuated, for the two great Indian epics, viz. the *Mahabharata* and the *Ramayana*. These need no longer be assigned to the realm of poetic fancy. Indeed, archaeology has been able to demonstrate that the Painted Grey Ware settlement at Hastinapura was washed away by a heavy flood in the Ganga on whose banks the site stands. During excavation, not only was evidence found for large-scale erosion of the riverside face of the mound, but a part of the washed away material was also recovered from the bed of the river at a depth of about 15 metres. Further, the lowest levels of Kausambi have yielded a lateish variety of the Painted Grey Ware, implying that the end of the PGW settlement at Hastinapura and the beginning of the settlement at Kausambi were chronologically interlocked. An echo of this archaeological evidence is found in the Puranas where it is stated that during the reign of Nichakshu (who was the fifth ruler of Hastinapura after the conclusion of the Mahabharata war) a great flood occurred in the Ganga washing away the township of Hastinapura. As a result, the capital was shifted to Kausambi. The relevant text reads as follows:

Gaṅgayāpahrite tasmin nagare Nāgasāhvaye
Tyaktvā Nichakshurnagaram Kauśāmbyām sa nivatsyati

What better corroboration can one expect?

It must be remembered that in the ninth century B.C. — the probable time of the Mahabharata War — writing was unknown in the Ganga valley, the main theatre of this episode. However, all the sites associated with the Mahabharata story — whether it be Hastinapura, the capital of the Kauravas or Panipat, Sonepat, Bhaghpat, Indrapat and Tilpat (the five villages the Pandavas asked for to come to a truce with the Kauravas) or Mathura from where Lord Krishna hailed, or even Ahichchhatra, the home of Draupadi — all have yielded the Painted Grey Ware Culture as the lowest common denominator. Can there be any better bonding of these sites?

Some very significant discoveries have been made in the archaeology of the early historical period too. For example, the finding of sealings in a monastery at Piprawha, bearing the inscription *Devaputra-vihāre Kapilavastu bikkhu-saṅghasa* and *Mahā-Kapilavastu-bhikkhusaṅghasa* in Brahmi characters of the first-second century A.D., has set a seal on the controversy regarding the identification of the capital from where Suddhodhana, father of Lord Buddha, ruled. Likewise, the excavations at Antichak have brought to light extensive remains of yet another noteworthy ancient Buddhist University, — Vikramasila — dating back to the ninth century A.D. The work at Mathura has revealed the existence of a system of fortification in the form of a half-moon — a fact duly mentioned in the *Harivamśa* when it described the township: *ardhachandra pratīkāsā yamunātīra śobhitā*. Sisupalgarh has brought to light a square fortification, with two major gates on each side and a gridiron pattern of the roads inside. Datable to a few centuries before the Christian era, this pattern of town plan finds an echo in the near-contemporary text of Kautilya's *Arthashastra*.

Another very noteworthy discovery is that of an water-supply tank over 250-metres long at Sringaverapura. It consists of a feeding channel through which the water of the nearby Ganga was specially brought, a silting chamber, an initial tank again for siltation, a long main tank, a circular final tank having an elaborate staircase, spill channels, a crest and an exit channel for the discharge of excess water. Last but not the least, a series of sub-surface wells were also provided in the river bed, in order to obtain underground water in case the stored amount considerably decreased during the hot summer months. With these devices the Sringaverapura tank stands out as a unique example of Indian hydraulic engineering going back more than 2000 years ago.

Contemporary chronicles have thrown a great deal of light on medieval India, and archaeology too has not failed to make substantial contribution to our knowledge of this period. For, example, large-scale excavations at Hampi have brought to light many a buried monument of the Vijayanagara period. At Champaner in Gujarat very interesting details of town planning have been ascertained. Even in the case of Fatehpur Sikri, the capital of Akbar the Great, where sumptuous monuments still stand erect, archaeological excavations have added many new structures, including noblemen's houses and a paved street lined with shops.

Amongst the most notable achievements of Indian archaeologists in the early decades of Independence was the excavation of a very extensive site named Nagarjunakonda, which was to be submerged under the waters of the Nagarjunasagar Dam. The excavations brought to light, besides Buddhist and Brahmanical remains, a unique amphitheatre ascribable to the early centuries of the Christian era. But what was most commendable about the work at Nagarjunakonda was the physical transplantation, bit by bit, of the important excavated structures to a hill top that stands out in the midst of the vast lake that the dam has created. Since then the transplantation of ancient monuments has become an easy task for the archaeological community in India. Amongst such recent works may be cited the shifting to safer places of the Kudali Sangamesvera Temple and the Papanasi group of 26 temples which would otherwise have been drowned by the Srisailam Dam.

We know that the country was brought under one umbrella for the first time by Asoka the Great. But the seeds of this north-south integration had begun to be sown much earlier. From the archaeological point of view this evidence is provided by the occurrence of the Northern Black Polished Ware found at many sites in Tamil Nadu, the southernmost being Korkai, not far from Kanyakumari. The potsherds include some fine specimens in golden and silver hues, which are known to be amongst the earlier varieties in the middle Ganga basin, the heartland of this ware. This dispersal may well have taken place a few centuries before Asoka.

The activities of Indian archaeologists have not remained confined to the borders of India. As far back as the early 60s an Indian team set foot on Egyptian soil, working as part of an UNESCO project to save the monuments and sites which were to be submerged under the Aswan Dam. Besides bringing to light valuable remains of the prehistoric and protohistoric periods, the team was able to throw some interesting side-lights on the work. For example, a few of the protohistoric graves had been plundered and in one of them the team found a cigarette butt. Working with fine brushes, the team was able to retrieve not only the paper covered part, but also the burnt end with the ash still intact. On the butt there was an inscription, 'Coutarelli Frères', 'Alexandrie', 'le Caire', indicating that this brand of cigarette was manufactured in Alexandria and Cairo. Enquiries revealed that this particular brand was in vogue from the end of the nineteenth century to the early decades of the twentieth. It was then possible to pin-point the time of plundering to within that period. Wasn't this a fine piece of detective work?

More recently, another Indian team has carried out excavations in Bahrain. Besides laying bare a large number of graves, the team has discovered a seal of the Indus style, reconfirming trade contacts between Indian and West Asia in the third millennium B.C.

Indian expeditions abroad have not remained confined to excavations. Indian teams have helped other Asian countries in the preservation of their cultural heritage. In the late 60s and early 70s Indian experts carried out the conservation of the colossal statues of the Buddha at Bamiyan in Afghanistan. Our efforts were greatly appreciated not only by the Afghan Government but also by the world community.

Under a current programme, an expert team from India is engaged in conserving the world-famous twelfth century temple of Vishnu at Angkor Wat in Cambodia. This work too has drawn great appreciation the world over.

An altogether new front in Indian archaeology, not even thought of prior to Independence, has been opened up. This is marine archaeology. Work at Dwarka has brought to light structural remains from below the sea-level. The work at this site and in the neighbouring areas is to continue.

There are other aspects of archaeology which need to be highlighted. For example, people would like to know how we date the various cultures and associated objects. Prior to Independence comparative stratigraphy and typology were the sole means to fall back upon to ascertain chronological horizons, but now we use many new methods. At least two of these deserve special mention, the Carbon-14 method and the thermoluminiscence method. Let us describe these so that people know we are not 'cooking up' dates, but have some scientific methods to back up our statements.

From various platforms, we talk of unity in diversity, and a very good example of this lies in our ancient script. Even though south Indian languages may well belong to the Dravidian stock and the north Indian ones to the Aryan, do people know or, to put it differently, how many people really know that the scripts used for all these languages emanated from a common script going back to Asokan times. Can we not utilize this phenomenon to forge a common script, so that everybody is able at least to read every other language? A religious organisation in southern India has published some Kannad devotional songs and other material in the Devanagari script and people in the north are able to read these and even, with some effort, understand them. This clearly demonstrates that a common script can be a great unifying force, particularly at a time when fissiparous tendencies are raising their heads. However, let me make it at once clear that I am not pleading for the adoption of Devanagari as the common script. Far from it, but surely a common script can be forged if people become fully aware of the basic fact that all these scripts have a common ancestry, which they can draw upon and utilize for the sake of national integration.

Alas, we archaeologists have done precious little to bring the above mentioned achievements, techniques, and significant aspects of our cultural heritage to the notice of the general public. We seem to be content with writing highly technical reports, which rarely go beyond our own community, whether in India or abroad. Not infrequently these reports gather dust in libraries, nay even in the publication stores of academic institutions.

I, therefore, earnestly appeal to all my colleagues gathered here, whether they are members of the Indian Society for Prehistoric and Quaternary Studies or of the Indian Archaeological Society to give serious thought to the matter and take some concrete steps to change the status quo. On my part, I have a humble suggestion to make. Let us aim at producing popular booklets on appropriate topics, each booklet containing about a hundred pages of text and about a dozen illustrations. I have appended a list of forty such titles. Many more can be added to them, and some of the ones I have suggested may even be dropped. We are standing at the close of 1991. In August 1997 we will be completing fifty years of our Independence. Can we archaeologists offer as our humble present to the nation fifty such booklets on the occasion? Once we take the decision and start working, it does not really matter if by August 1997 all the fifty booklets are not out. A substantial number, however, could be ready. Let us here and now, at a special sitting this evening, discuss ways and means to give a practical garb to this seemingly utopian idea. At this meeting authors can be floated. Members can then constitute a small committee to go further into the matter.

There are two more things to be kept in mind about these popular booklets. One, that while they should be decently produced, the price should be kept as low as possible. For this reason the authors should be willing to forego their royalties. We should also approach the Central and State Governments, foundations and business houses to give us financial support for this national project. With their help, the publications can be subsidised and the prices kept to the minimum. Secondly, these booklets should be translated into and published in all the languages of the country. I have every hope that the various State Governments will readily undertake this second part of the job. Without this, the gain would be only peripheral, touching only the elite crust and not going deep into the core of society.

Lastly, we must not forget that it is public money that we are using for our researches and excavations. The public has every right to turn round and say: "You archaeologists, why are you squandering our money? Unless you give us an account of what you have been doing, we may well reserve the right to withhold funds." I am sure none of us wants this hypothetical threat to become a reality.

At the end, I would like to thank all concerned who have given me an opportunity to publicly express an idea which has been haunting my mind for the past two or three years.

Titles and subjects suggested for the proposed series of archaological booklets:

New Light on Our Heritage OR
Archaeological Discoveries at Your Door

1. The Earliest Hunters and Gatherers
2. Bhimbetka: An Open-Air Art Gallery of Stone Age Man
3. Rock-Paintings: A Storehouse of Cultural Information
4. From the Cold Clime of Kashmir: Neolithic Burzahom
5. Neolithic Cattle-Breeders of South India
6. India and the Indus Civilization
7. Lothal: the Earliest Mariners
8. Surkotada: A Harappan Station in Kachch
9. Dholavira: Unique Harappan Town Planning
10. Kalibangan: Evidence or two 'Earliest' — an Agricultural Field and an Earthquake
11. Deciphering the Indus Script: A Tale of Failures and Successes
12. Then and Now: Survivals of Patterns of Living from Third Millennium B.C.
13. The Enigmatic Copper Hoards no Longer Float in the Air
14. Central India and the Deccan: No Longer Terra Incognita
15. The Largest Prehistoric Bronzes: A Gift from Daimabad
16. Agriculture in Ancient India: New Light
17. Domestication of Animals in Ancient India: New Light
18. Dating the Past: Some New Techniques
19. The Historicity of the Two Indian Epics: What Has Archaeology to Say in the Matter?
20. Indraprastha: Earliest Delhi
21. From the Village to the City in the Ganga Basin
22. A 2000-year Old Marvel of Indian Hydraulic Engineering: The Tank at Sringaverapura
23. A Uniquely Planned Township in Eastern India: Early Historical Sisupalgarh
24. Vikramasila: The Unearthing of Another Ancient University
25. Megalithic Burials of South India: Some New Aspects

26. New Discoveries at Hampi — the Vijayanagara Capital
27. Understanding Medieval India: Here Too Archaeology Lends a Helping Hand
28. Repairing the Colossal Buddha Figures in Afghanistan
29. The Angor Wat Temple: A Challenge in Archaeological Conservation
30. The Basic Unity of Indian Scripts
31. More of What the Emperor Asoka Bequeathed to Us in Writing
32. Propping up the Qutab Minar
33. Salvaging Our Heritage: The Srisailam Project
34. Deep in the Himalayas: Conserving the Ki and Tabo Monasteries
35. Nagarjunakonda: A Unique Experience in Excavation and Conservation
36. The Sun Temple at Konarak: A Fresh Lease of Life
37. Mahabalipuram: Meeting the Challenge of the Sea
38. The Unique Churches of Goa: Their Architecture and Upkeep
39. The Eternal Taj: No Cause for Alarm
40. A New Chapter in Indian Archaeology: Discoveries from Below the Sea

The Composition and Smithery Techniques of Copper Artefacts from Nagwada — A Preliminary Study

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Abstract

Samples of copper artefacts recovered from the stratified horizons of excavations at Nagwada, a mature Harappan site in North Gujarat, were subjected to chemical and metallographic analyses in order to locate the provenance of the raw material and to reconstruct the smithery techniques. Studies were carried out using energy dispersive X-ray micro analysis, atomic absorption spectrophotometry and reflected light microscopy. These analyses have revealed that the axes were made of pure unalloyed copper, while the chisel was of bronze. It was also observed that the axes were cast in a smooth well-ventilated mould while the chisel was fabricated by simply cold hammering it to the required shape.

Introduction

The invention of metal technology and the art of fabricating metal artefacts may be considered one of the outstanding achievements of mankind, following the Neolithic revolution. This physical and chemical processing of the ore has made it possible to use it in a variety of arts and crafts. Moreover, this mastery over metal working enabled man to make considerable changes in all walks of life and led him to the threshold of urbanization. The antiquity of metals goes back to the seventh millennium B.C., as evident from the archaeological assemblages in western and central Anatolia, across the flanks of the Taurus and Zagros mountains, to the edge of the central desert of Iran (Wertime 1964). In the Subcontinent the earliest evidence of metals appears in the aceramic Neolithic levels of Mehrgarh and Mundigak (Jarrige 1982; Allchin, B. and R. 1982).

Though there was a gradual increase in the quantity of metal artefacts during the Pre-Harappan period, it was the Harappan culture that witnessed a sudden efflorescence of metal objects, especially copper. These have been discovered in various forms, ranging from utilitarian objects to intricate pieces of art and ornamentation. The main tool types of the Harappans were razors, leaf-shaped knives, chisels, spearheads, sickle blades, axes, mid-ribbed daggers, drills and eyed needles. The dancing girl from Mohenjo-daro and the animal figurines of a dog, a swan and a bull are examples of their skillful casting.

Metals contain within them the history of their making. Technical studies of metal antiquities are widely used to unravel the mysteries of the metal technology of the various protohistoric societies. Archaeometallurgical studies in the Indian subcontinent have mainly concentrated on the typology and technology of various cultural traditions. Chemical analyses and metallographic studies have helped in assessing the smelting and smithery techniques. Provenance determinations have also been carried out successfully by comparing the impurity pattern of the representative samples with that of the ores.

The author had an opportunity to analyse a few copper artefacts from Nagwada, a mature Harappan site in North Gujarat (Fig. 1) (Seshadri 1990). The mature Harappan affiliation of the site has been proved on the basis of the material relics obtained from the excavations. Radiocarbon date for Nagwada is 3700 ± 80 B.P. (Lab No. A-4555) (Half life 5568) (Bhan 1989).

The excavations at Nagwada (23°20' N : 71°41' E) have revealed five distinctive layers and four structural phases. In the upper layers we came across mud brick and

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This paper was selected for the first Professor H.D. Sankalia Memorial Young Archaeologist Award and the author presented it at the XIX Annual Conference of the Indian Society for Prehistoric and Quaternary Studies, Bhopal, December 16-18, 1991.

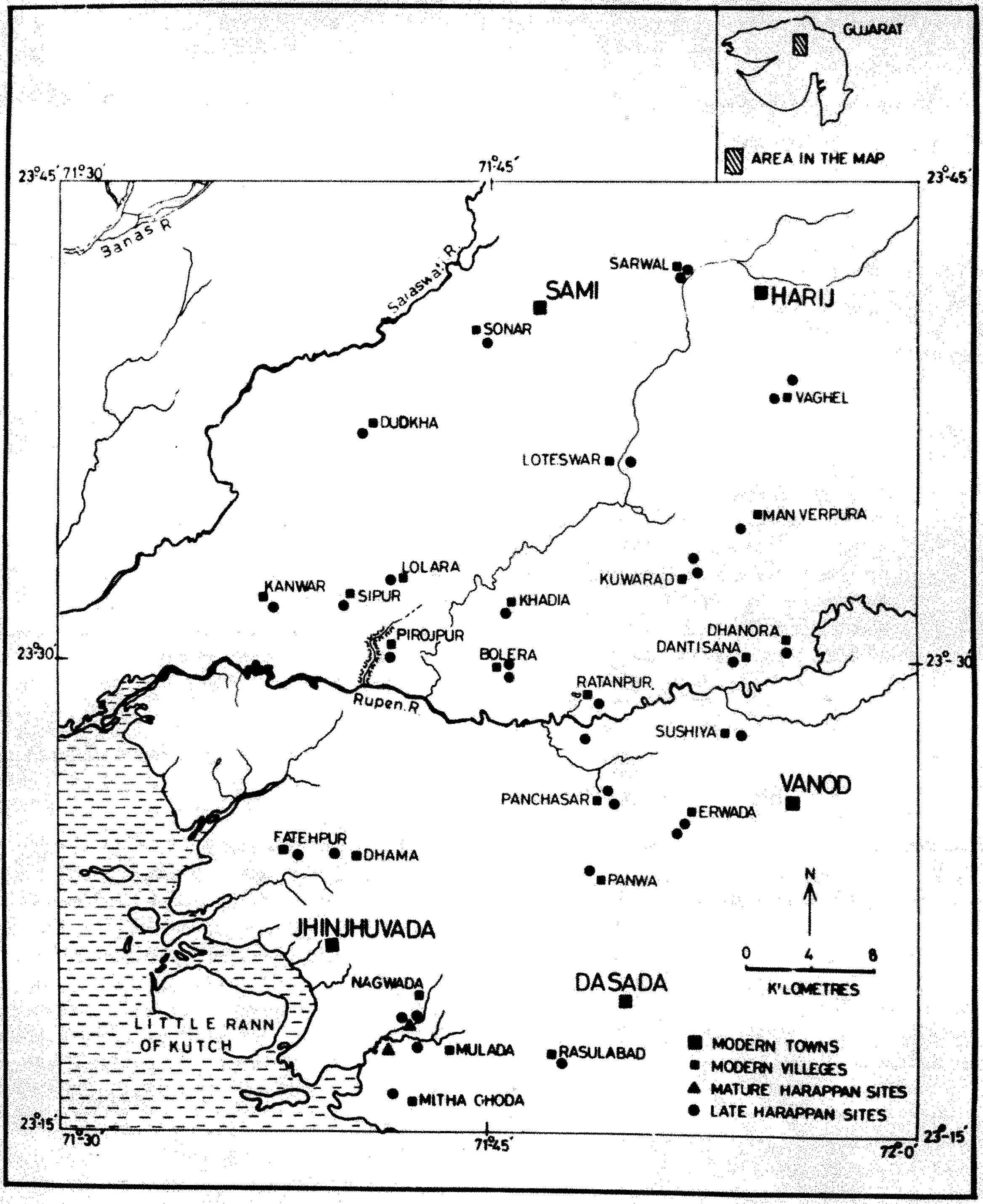

Fig. 1: Harappan settlements of the Rupen Estuary, North Gujarat

rubble structures, while the lowermost layer yielded extended and pot burials. The burials contained pottery such as dish-on-stand, beakers with a slightly flaring mouth, shallow dishes and short-necked bulbous vessels which show some affinities with Pre-Harappan pottery from Amri and Nal (Hegde *et al.* 1988).

Above the graves was a one metre thick deposit consisting of four, well-defined structural phases. Two post holes in Layer 5 marked the earliest structural evidence at the site. The fourth, third and second layers yielded mud brick and rubble structures.

Besides a variety of stone artefacts like long, parallel-sided chert blades, stone blades and waste flakes, Nagwada has also yielded objects of shell in various stages of manufacture. Two species of gastropods, *Turbinellapyrum* and *Chicoreus ramosus*, were exploited to produce bangles,

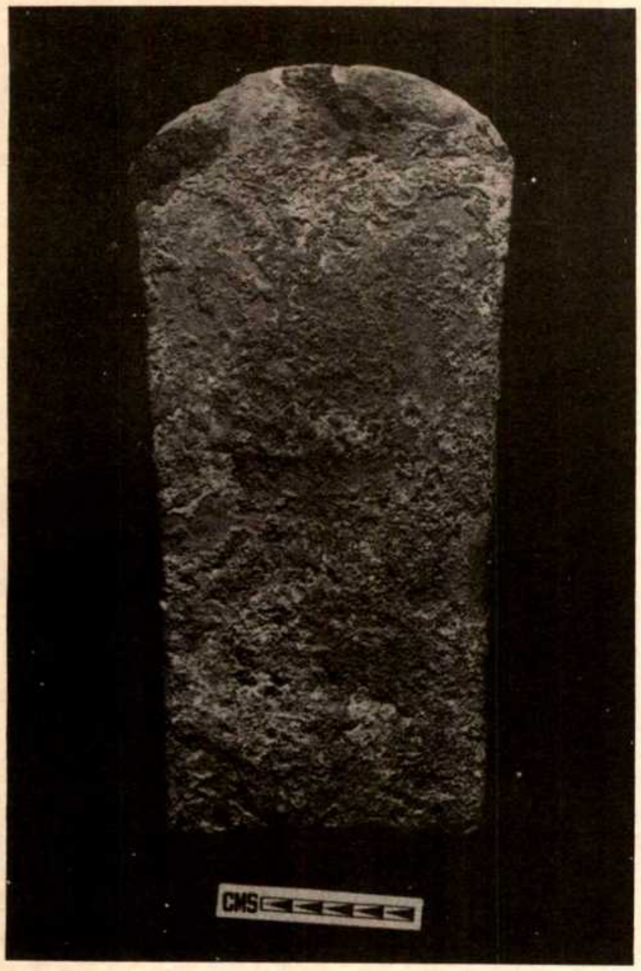

Fig. 2: The axe from Nagwada

beads, pendants and inlay pieces. Beads of steatite, lapis lazuli, amazonite and faience have also been unearthed. *Mushtikas* (lumps of well baked clay made by hand and showing finger impressions) and triangular terracotta cakes have been found in all the layers. An interesting aspect of the site was the discovery of a small mother goddess figurine and an inscribed clay sealing.

The predominant pottery type among the typical Harappan wares was the Red ware. Among the major Harappan shapes, S-profile jars, dish-on-stand and perforated jars were also encountered. Besides Harappan wares, plenty of non-Harappan wares like the coarse gritty ware and the white painted Black and Red ware were also present.

Nagwada has yielded artefacts of gold, silver and copper. Four copper axes have also been unearthed during the excavations. Three of these are similar, weighing about 1800 gms each. These axes are 26 cm in width at the hafting end, and 16 cm at the cutting edge (Fig. 2). The copper axes of Nagwada show typological similarities with the Surkotda axes of Ib phase (Joshi 1972). The fourth axe is slightly smaller than the others. Besides these, a chisel measuring 7.5 x 0.8 x 0.4 cm was found at Nagwada (Fig. 3). Similar chisels have been reported from Mohenjo-daro (Marshall 1931). However, the excavations have not yielded any evidence which throws light on their metallurgical processes.

Besides the axes and the chisel, the site has also yielded a copper scroll, bangles and pendants and various other unidentifiable pieces of copper. Of these a few samples were subjected to chemical analyses and metallographic studies with a view to:

1. determining the chemical composition of the representative samples in order to assess their smelting technology;
2. understanding the smithery techniques that were employed in the manufacture of these objects;
3. tracing the provenance of the ore used as raw material.

Materials and Methods

Representative specimens subjected to metallographic studies and chemical analyses included portions from the butt end and working edge of the axe and the chisel.

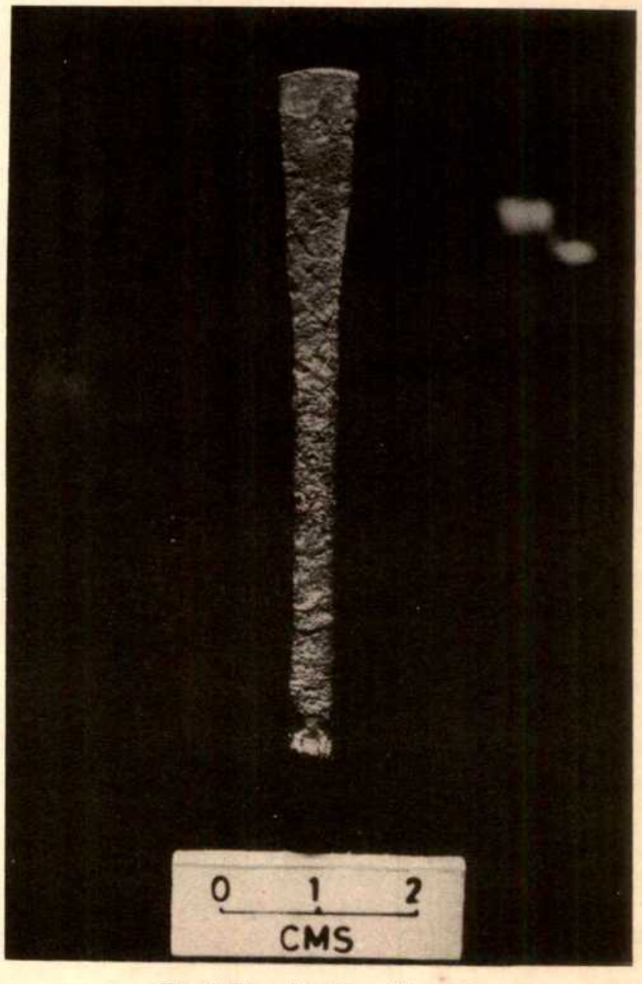

Fig. 3: The chisel from Nagwada

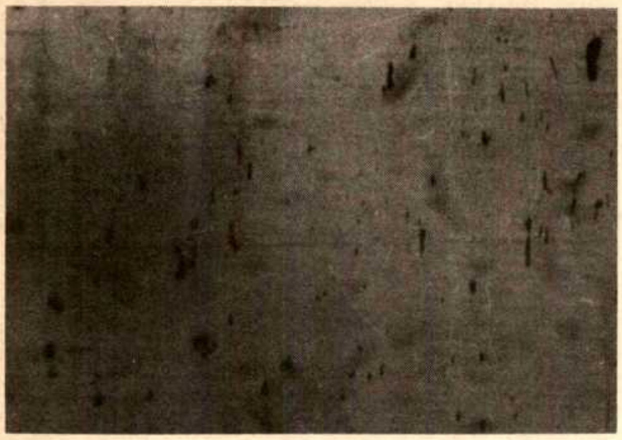

Fig. 4: Photomicrograph of the axe (X98), showing unetched, compact nature of the metal and globular inclusions

Chemical analyses of the representative samples were carried out using energy dispersive X-ray (EDAX), micro analysis and atomic absorption spectrophotometry (AAS).

In order to study the smithery techniques, the polished sections were examined under reflected light, using a Leitz Laborlux 12 Pol D.

The transverse sections of the samples were polished with different grades (0.3/0.4/0) of emery paper. The final polishing was done by velvet cloth attached to a polishing machine rotating at a speed of 450 r.p.m. using polishing alumina of grade III diluted with 19 volumes of distilled water.

The etching of the samples was done with 5 parts of ammonium hydroxide and 3 parts of hydrogen peroxide for 75 seconds.

Results

1. *Chemical Analysis*: The axe contains 96.1% copper and 2.72% arsenic. Nickel and lead are also present in appreciable quantities. The trace elements were determined by atomic absorption spectroscopy (Tables 1 and 2). These elements included cadmium, magnesium, iron, calcium, cobalt, zinc and antimony.

The percentage of copper in the chisel is 86%. The chisel also contains 10.6% of tin. It is interesting to note the absence of arsenic in this implement. Lead is present in appreciable quantity, i.e., 3.2%. The trace element pattern of the chisel is similar to that of the axe.

2. *Metallography*: Microscopic analysis of the axe revealed grey globular inclusions (Fig. 4). The etched sample revealed grain boundaries and cellular structures (Fig. 5).

The butt end of the chisel revealed globular inclusions. A portion of the etched section of the butt end revealed slip lines and cross sliplines (Fig. 6). Lead inclusions and slip lines were also observed on the etched section of the cutting edge (Fig. 7).

Discussion

1. *Chemical Composition*: On the basis of analytical data obtained from the EDAX and AAS, it can be deduced that the axe was made of relatively pure copper. The high percentage of copper in the axe is an indication of a fairly good smelting technology. The appreciable quantity of arsenic in the axe is significant. Arsenic when present in about 2-3% is highly beneficial, especially for cutting implements, but if it exceeds 3%, it renders the metal brittle. Arsenic also acts as a deoxidiser and facilitates closed casting (Agrawal 1970). Arsenic is a common constituent of many copper ores like energite and famatinite and passes on to the constitution of the metal without much loss in quantity unless it is roasted for a long period of time at a temperature higher than 500°C. At such a high temperature, arsenic becomes volatile and a part of it escapes as vapour. This, the Harappan smiths learned by experience, as indicated by the presence of higher amounts of arsenic in the earlier objects as compared to the subsequent ones. Thus, the optimum percentage of arsenic in the axe may be attributed to the proper roasting of the ore.

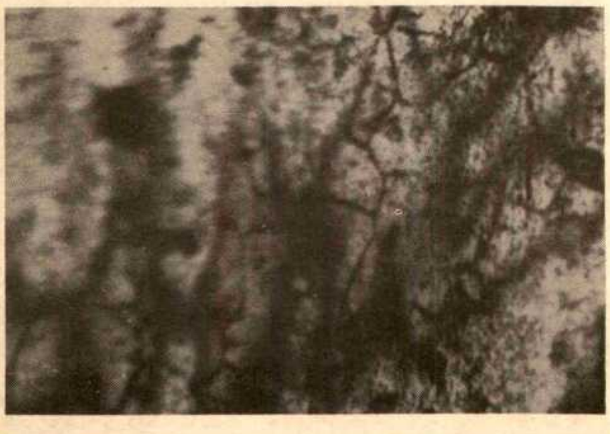

Fig. 5: Photomicrograph of the axe (X240), clearly showing presence of cellular structure

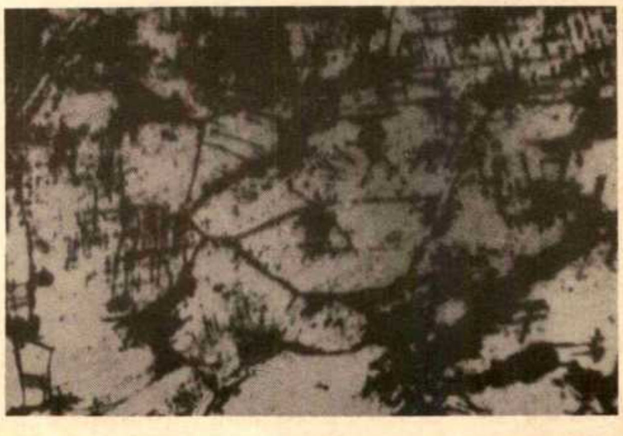

Fig. 6: Photomicrograph of the butt end of the chisel (X250) with sliplines and grain boundaries

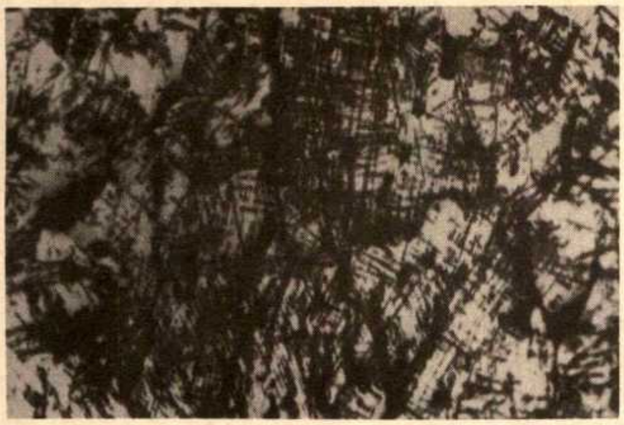

Fig. 7: Photomicrograph of the cutting edge of the etched chisel (X98), showing sliplines and cross sliplines

Lead passes on to the constitution of the metal from the ore without much loss in quantity. It does not form a solid solution, but distributes itself in the form of globules. Lead and copper, both being soft metals, are not suited for cutting implements. However, the presence of lead improves the feasibility of copper and facilitates casting. Nickel and silicon have been derived as impurities from the one.

Iron is a common constituent in most copper ores like chalcopyrite, pyrolite, etc. Iron is present in the axe in traces only. The complete removal of iron is a difficult task and requires a temperature as high as 1200°C. At such a high temperature we get liquid slag and liquid metal. The two are separated due to differences in partition co-efficients. The negligible amount of iron in the axe may be attributed to the attainment of a very high temperature in the smelting furnace. Hence, the Harappans who manufactured the axe had a sound knowledge of smelting technology.

Cadmium, zinc, magnesium, calcium, cobalt and antimony are included in the constitution of the metal as impurities from the ore.

In contrast to the axe, the composition of the chisel indicates that it has been made of bronze. Tin, when added to copper, increases the strength of the implement and gives it a more enduring cutting edge. An optimum alloy of bronze is obtained when tin is present between 3-12%. Bronze has several advantages over copper. Besides being stronger it is also more malleable and ductile. Tin also acts as a deoxidising agent. When the molten metal is poured into the mould, the air trapped inside the mould escapes through the vents. The oxygen trapped inside dissolves in the molten metal and forms cuprous oxide which is represented by gas holes in the object. Tin reduces the amount of gas holes considerably and makes the casting process easy and efficient.

Like the axe, the chisel also contains a very high percentage of lead. The complete absence of arsenic in the composition of the chisel may be due to the absence of arsenic in the ore itself.

2. *Provenance*: An attempt was made to trace the provenance of the raw material by comparing the trace element pattern with that of samples from Khetri, Kolihan, Singhana and Ambaji. The impurity pattern of the samples does not tally with any of the above-mentioned ores. Further analyses for provenance determination are being carried out by the author.

3. *Smithery Techniques*: From the microscopic examination of the axe, it is possible to infer that it was cast in a smooth, well-ventilated mould. The presence of a few gas holes attests to this fact. The gas holes are produced when oxygen dissolves in molten copper to form cuprous oxide. This is due to improper ventilation in the mould. The presence of cellular structures and grain boundaries and the absence of any sliplines or twinning is an indication that the axe was put to use without any further alteration to its shape or thickness. The butt end of the axe was not subjected to any hot or cold treatment. The absence of any dendritic structures may be attributed to the repeated heating of the axe in order to bevel the cutting edge. The cellular structures also indicate that the axe was cooled slowly.

The sliplines and cross sliplines on a portion of the butt end of the chisel are a result of the cold work to which it was subjected in order to give it the desired shape.

The working edge of the chisel has undergone extensive cold work (any work that is carried out on the metal below the temperature of re-crystallisation). This end of the

Table 1: The chemical composition of different elements in the artefacts from Nagwada as revealed from EDAX studies

Specimen No.	Description of the sample	Elements present					
		Copper Cu	Silicon Si	Nickel Ni	Arsenic As	Lead Pb	Tin Sn
NGW 1778	Axe	96%	0.26%	0.32%	2.72%	0.69%	nd
NGW 164	Chisel	85.64%	0.57%	nd	nd	3.2%	10.6%

nd = not detected

Table 2: The chemical composition of trace elements in the copper artefacts from Nagwada as revealed from AAS studies

Specimen No.	Description of the sample	Elements present in PPM									
		Cd	Mg	Fe	Ca	Co	G	Zn	Ni	Sb	Au
NGW 1778	Axe	10	200	800	300	50	nd	70	2000	100	nd
NGW 164	Chisel	10	150	60	300	20	nd	310	450	100	nd

nd = not detected

chisel was beaten in order to give it a keen cutting edge. Cold work on copper increases the hardness of the metal considerably.

Thus it is possible to conclude that:

1. The axe was made of pure copper. It was cast in a smooth, closed, well-ventilated mould and cooled slowly. It was not subjected to any hot work or cold work at the butt end.
2. The chisel was made of bronze. It was fabricated by cold hammering it to the required shape. The working edge was cold worked in order to make it more enduring.

Acknowledgements

This study was undertaken as part of the Masters programme in the Department of Archaeology of the M.S. University of Baroda. I wish to record my sincere thanks to Prof. K.T.M. Hegde for his guidance during this study. I also wish to thank Dr. K.V. Rao and Dr. G.C. Pandey of the Research and Development Wing of the Indian Petrochemicals Corporation Limited for analysing the samples. My thanks are also due to Dr. V.H. Sonawane and Dr. K. Krishnan for helping me at various stages of this work. Last but not the least, I also acknowledge the help of Prof. V.S. Parekh and Dr. K.K. Bhan.

I am also thankful to the Ford Foundation for financing and equipping the laboratory in the department.

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The Phenomenon of River Migration in Northern Tamil Nadu — Evidence from Satellite Data, Archaeology and Tamil Literature

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Abstract

Satellite photographs depict exciting evidence of the migratory melodrama of river systems. A study has been conducted in parts of Tamil Nadu using IRS-IA satellite pictures, archaeology and Tamil literature, which reveals that from Pleistocene to 2700 years B.P. the river Kaveri flowed in a northeasterly direction from the Stanley Reservoir via Chinnar, Palakkodu, Mattur, Tiruppathur (Tirupattur), Gudiayatham (Gudiyattam), Vellore and Walajapet to meet the sea at Madras. From 2700 to 2300 years B.P. it flowed via Uttangarai and Tirukovilur to meet the Bay of Bengal near Pondicherry, over which the present-day Ponnaiyar is a misfit stream. From 2300 to 1300 year B.P. it has flowed via Erode, Tirukampuliyur, Alagarai, Tiruchy, Kiranur and Pudukkottai meeting the sea in the region where the present-day Agniyar and Ambuliar meet the sea. Subsequently, between 1600-1300 years B.P. the Kaveri flowed along the present-day tract of the Vennar and Vettar, after which it seems to have flowed as the Kodamurutti, Arasalar and Palankaveri from 1300 to 1000 years B.P. From about 900 years B.P. it flowed via Tirupurampayam (Tirupurambiyam), Achalpuram till around 750 years B.P. it stabilised as the Colliroon (Kollidam). Such periods and phases of river migration as well as their implications in the search for archaeological remains are discussed in this paper.

Introduction

Aspects of river migration have been discussed by many and at length since Vedic times. A study of the *Mahabharata* shows that the Yamuna river was flowing 60 to 70 kms west of its present-day course in the Agra-Mathura stretch during the period of the Epic. Places where Lord Krishna is said to have played with the *gopis* along the banks of the Yamuna, today are flat and vast agricultural plains in the Mathura area. In the same vein Chamberlein (1894) has narrated that once upon a time there was only a single river system in extra peninsular India called the "Indobrahm" and the said river originated in Assam and flowed in a west-southwesterly direction along the Indo-Gangetic plains and through the Great Indian Desert to debouch into the Arabian Sea in the Rann of Kachchh. This river is said to have divided into the Brahmaputra, Ganga, Yamuna and Indus as a result of tectonic activity in the Himalayan region. There is still a belief among people that the Trivenisangam near Allahabad is the meeting place of the Ganga, Yamuna and Saraswati and pilgrims take a holy dip here in large numbers even today. Currently, only two rivers — the Ganga and the Yamuna — meet at the Trivenisangam. The Saraswati is said to have migrated towards the Great Indian Desert where it has now been lost sight of.

Tamil literature provides a good deal of information about the migratory history of the rivers of Tamil Nadu. Examples include the Kaveri's disappearance near Hogenakal (Singaravelan 1976), the Palar's migration near Kanchipuram, mentioned in the *Kalingathu Parani*, evidence for the existence of the Ponnaiyar near Tiruvennai Nallur (in *Thevaram*) and mention of the Kaveri in the Kumbakonam-Achalpuram tract during *Periyapuranam* times. While Tamil literature has been a source of such information, the advent of modern aerial photography and satellite imagery has opened up new vistas in the study of the migratory history of rivers.

Ramasamy *et al.* (1987) have brought to light a spectacular network of buried river systems in Tamil Nadu based on regional Landsat imagery studies. They have mentioned that the Kaveri river must have flowed in a northeasterly direction from the present-day Stanley Reservoir, via the

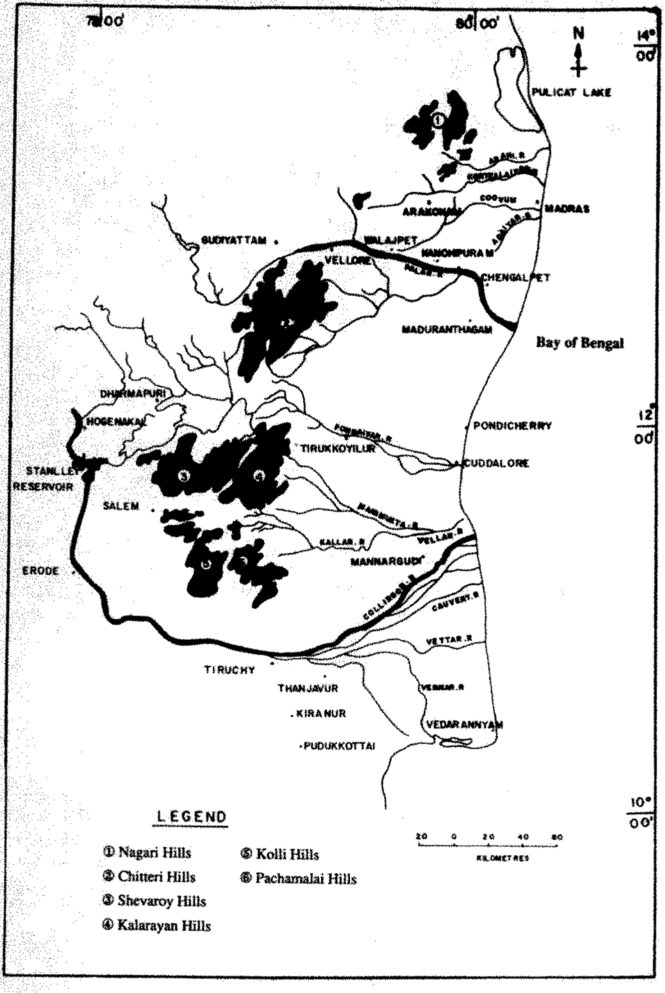


Fig. 1: Northern part of Tamil Nadu comprising the study area

present-day Palar to meet the sea just north of Madras city, supporting the early conjecture of Foote (1901) and later, that of Vaidyanadhan (1971). Ramasamy *et al.* (1991) have also, on the basis of their remote sensing studies, elucidated the migratory pattern of all the river systems of western India and further explained the migration of these rivers through a Pleistocene tectonic model. Backliwal and Sharma (1980) have also identified frequent migration of the Yamuna river near Agra. Thus modern satellite photographs have helped enormously to provide information on fluvial migration.

The present study attempts to throw light on the migratory network of the Tamil Nadu rivers and to integrate this information with known archaeological data and also with evidence from Tamil literature so as to:

a) reveal phases and periods of migration, and

b) based on this to bring to light areas for archaeological investigation, and

c) also to focus on possible zones of neotectonism and groundwater reservoirs.

Materials and Methods

In the present study, raw as well as digitally enhanced Landsat Thematic Mapper data and IRS satellite data were used to identify all the old river courses.

The present-day drainage network was studied using Survey of India toposheets and the palaeochannel network was based on interpretations of the above satellite data. The latter are quite spectacularly revealed as linear, curvilinear, loop-like and ribbon-like dark features in black and white satellite photographs and as those with a reddish tone in the colour coded photographs. Literature describing archaeological remains from various parts of northeastern Tamil Nadu was collected, the geographical locations of these sites were then plotted over the palaeochannel network map. Data was also collected from ancient Tamil literature regarding the geographical locations of the old river systems and these too were plotted on the palaeochannel network map. These three types of data bases were then integrated and the periods and phases of the migratory systems identified so as to provide favourable areas for the search for new archaeological remains.

Regional Geography of the Area

The area of study comprises the northern part of Tamil Nadu. It is bordered by the Pulicat Lake in the north, Point Calimere in the south, the Stanley Reservoir in the west and the Bay of Bengal in the east (Fig. 1). The Palar river flows through the northern part of the study area. It originates in the Nandi Hills in Kolar District, Karnataka, flows mainly in an east-northeasterly direction in its initial stretch, then takes an east-southeasterly turn and finally reaches the Bay of Bengal after flowing through Vellore, Walajapet, Kanchipuram and Chengalpattu. The river Ponnaiyar, popularly known as the Southern Pennar, originates in Sengarayanpeta in Karnataka and flows in a generally south-southeasterly direction initially and then flows in an easterly direction before meeting the Bay of Bengal near Cuddalore. The Javadi Hills separate these two rivers.

The Manimukta-Vellar river systems of the Attur region originate in the Kalrayan Hills and have a general east-southeasterly flow. The Kaveri river which flows eastward up to Hogenakal, then flows in a Z-shaped pattern till it flows into the Stanley Reservoir. From here to the present-day confluence near Chidambaram, it assumes a semi-circular shape. The Vellar river system in the north and the Kaveri river system in the south are regionally separated by the Kolli Hills and Pachamalai Hills.

Palaeochannel Network in Tamil Nadu

Around Madras

An interpretation of the raw and the digitally enhanced (LANDSAT MSS, TM AND IRS-IA) data shows an array of

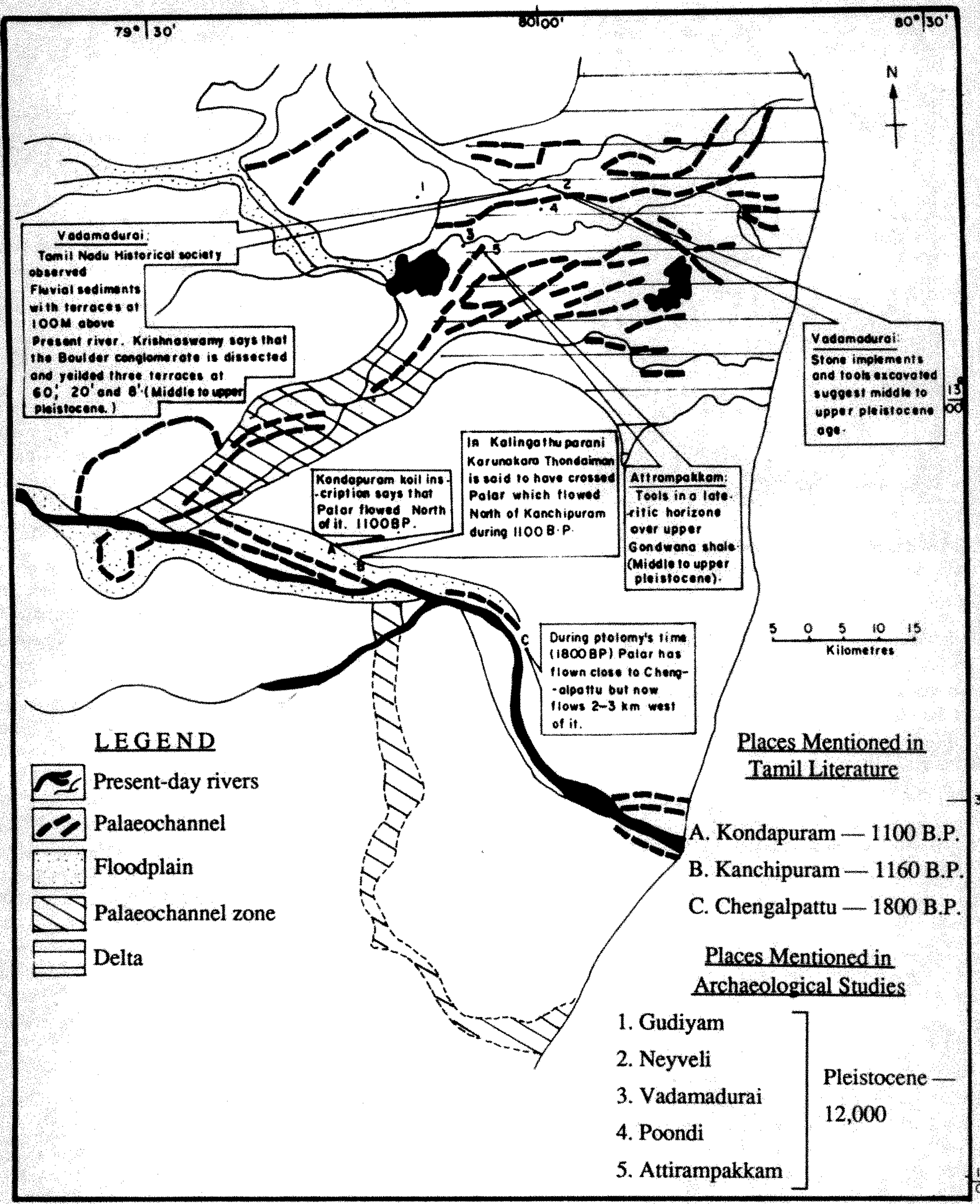

79° | 30'
80|00'
80° | 30'
N
13 | 00
30'
12° | 00
1
2
3
4
5
A
B
C
Vadamadurai:
Tamil Nadu Historical society observed Fluvial sediments with terraces at 100M above Present river. Krishnaswamy says that the Boulder conglomerate is dissected and yeilded three terraces at 60', 20' and 8' (Middle to upper pleistocene.)
Vadamadurai:
Stone implements and tools excavated suggest middle to upper pleistocene age.
In Kalingathuparani Karunakara Thondaiman is said to have crossed Palar which flowed North of Kanchipuram during 1100 B.P.
Kondapuram koil inscription says that Palar flowed North of it. 1100BP.
Attrampakkam:
Tools in a lateritic horizone over upper Gondwana shale (Middle to upper pleistocene).
During ptolomy's time (1800BP) Palar has flown close to Chengalpattu but now flows 2–3 km west of it.
5 0 5 10 15
Kilometres
LEGEND
Present-day rivers
Palaeochannel
Floodplain
Palaeochannel zone
Delta
Places Mentioned in Tamil Literature
A. Kondapuram — 1100 B.P.
B. Kanchipuram — 1160 B.P.
C. Chengalpattu — 1800 B.P.
Places Mentioned in Archaeological Studies
1. Gudiyam
2. Neyveli
3. Vadamadurai
4. Poondi
5. Attirampakkam
Pleistocene — 12,000

Fig. 2: The palaeochannel network of Madras region

palaeochannels in and around the present-day river systems.

North of Madras city (Fig. 2) a major palaeochannel network is observed. These palaeochannels branch off from the present-day Palar river just east of Walajapet and are seen to turn and flow in an east-northeasterly direction up to Sathyamoorthy Sagar (Fig. 3). Further to the east and northeast of Sathyamoorthy Sagar the palaeochannels show a regional distributary network (Fig. 2) suggesting a

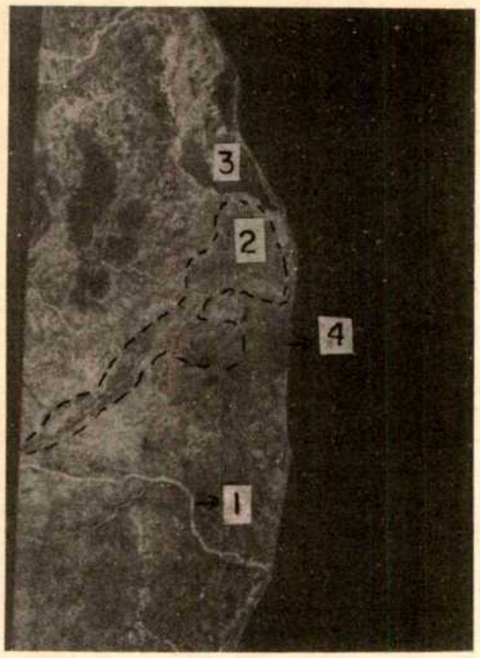


Fig. 3: Satellite picture showing palaeochannels in Madras region 1. present-day Palar 2. palaeo-Palar delta 3. Pulicat Lake 4. Madras

palaeodeltaic environment, and showing a well-developed bird foot-shaped delta with deltaic lobes and complementary depressions. The apex of this delta lies at least 20-30 kms west of the present-day coast near Sathymoorthy Sagar (Figs. 2,3 and 4). This clearly indicates that the sea shore might have been 5-10 kms west of the present-day coast.

Currently, however, this deltaic regime which has its regional axis in a NE-SW direction is superposed by easterly flowing small rivers like the Araniyar, Korttalaiyar (Kortalayar), Adaiyar and Coovum (Fig. 3). The satellite photographs also clearly depict a very broad floodplain which is over 5 km wide on the northern banks of the Palar in the Kanchipuram region and within which two prominent palaeochannels are observed (Fig. 2). On either bank of the Palar in the Chengalpattu area, and within this floodplain, conspicuous meander scars can also be seen. Immediately west of Chengalpattu, a 2.5 km wide palaeochannel is observed, having a N-S orientation and encircling Madurandagam (Madurantakam) to meet the sea near Attur-Thalankadu. The Cheyyar, which is a major tributary of the Palar, has a very narrow channel, but a wide floodplain (1-2 km) in the area south of Mamandur (Fig. 2).

The author has earlier argued (1990) that such a large bird foot-shaped delta was probably deposited by a mighty river system which once drained this region and not by streams like the Araniyar, Kortalayar, Adaiyar and Coovum because:

1) the present-day streams are easterly flowing whereas the axis of the delta is northeast-southwest, and
2) these present-day streams are comparatively very small.

All this clearly shows that the Palar river once flowed away from Walajapet, in a northeasterly direction forming a delta north of Madras city where it met the Bay of Bengal.

Dharmapuri-Stanley Reservoir Region

In this region satellite photographs clearly depict a network of palaeochannels in the Kaveri drainage basin (Fig. 5).

The interpretation of satellite photographs has brought to light these network of palaeochannels in the Stanley Reservoir region. The palaeochannels observed along the present-day Chinnar (Fig. 4) date back to between 2700 and 2300 years B.P. (Rajan 1991). This suggests that the Kaveri would have flowed in a northeasterly direction from Hogenakal to meet the Palar via Palakkodu, Mattur and Tirupathur (Tirupattur) (Fig. 5). Today the Chinnar flows towards the southwest. These types of drainage reversals have been explained as being the result of Pleistocene upheavals (Ramasamy 1991).

Another set of palaeochannels are seen to connect the Stanley Reservoir to the present-day Ponnaiyar through Ottupalam (11), Oddaipatti (12), Mensai (13), Jammanahalli (14), Harur (15) and Chellampatti (16) (Fig. 4).

Tirukkovilur-Villupuram Region

Here again, the colour coded (not seen in these photos) and computer processed satellite photographs exhibit a well-developed network of palaeochannels in the Ponnaiyar basin (Figs. 6 and 7). The palaeochannels observed in the Villupuram region show sub-parallelism and also a regional distributary pattern relative to the flow of the present-day Ponnaiyar. Some of the palaeo-distributary channels branch off from the parent river, the Ponnaiyar, but are then buried within the deltaic plains before reaching the sea. A few other examples showing the phenomenon of channel avulsion are the northern Malattar and the southern Malattar. The word *Malattar* means 'not meeting the sea' and the same applies to the Tamil version of the word *Sukni* in Hindi.

Salem-Attur-Chidambaram Region

A faint palaeochannel is observed with an ENE-WSW orientation along Idappadi-Salem-Vazhappadi (Fig. 8), and connects the present-day Kaveri with the present-day Vashista Nadi which is a tributary of the Vellar (Figs. 4 and 8). Further downstream the Vellar shows numerous palaeochannels on its northern bank in the area south of Sengamedu and also another set of palaeochannels in its deltaic region in the area west of Chidambaram (Figs. 7 and 8).

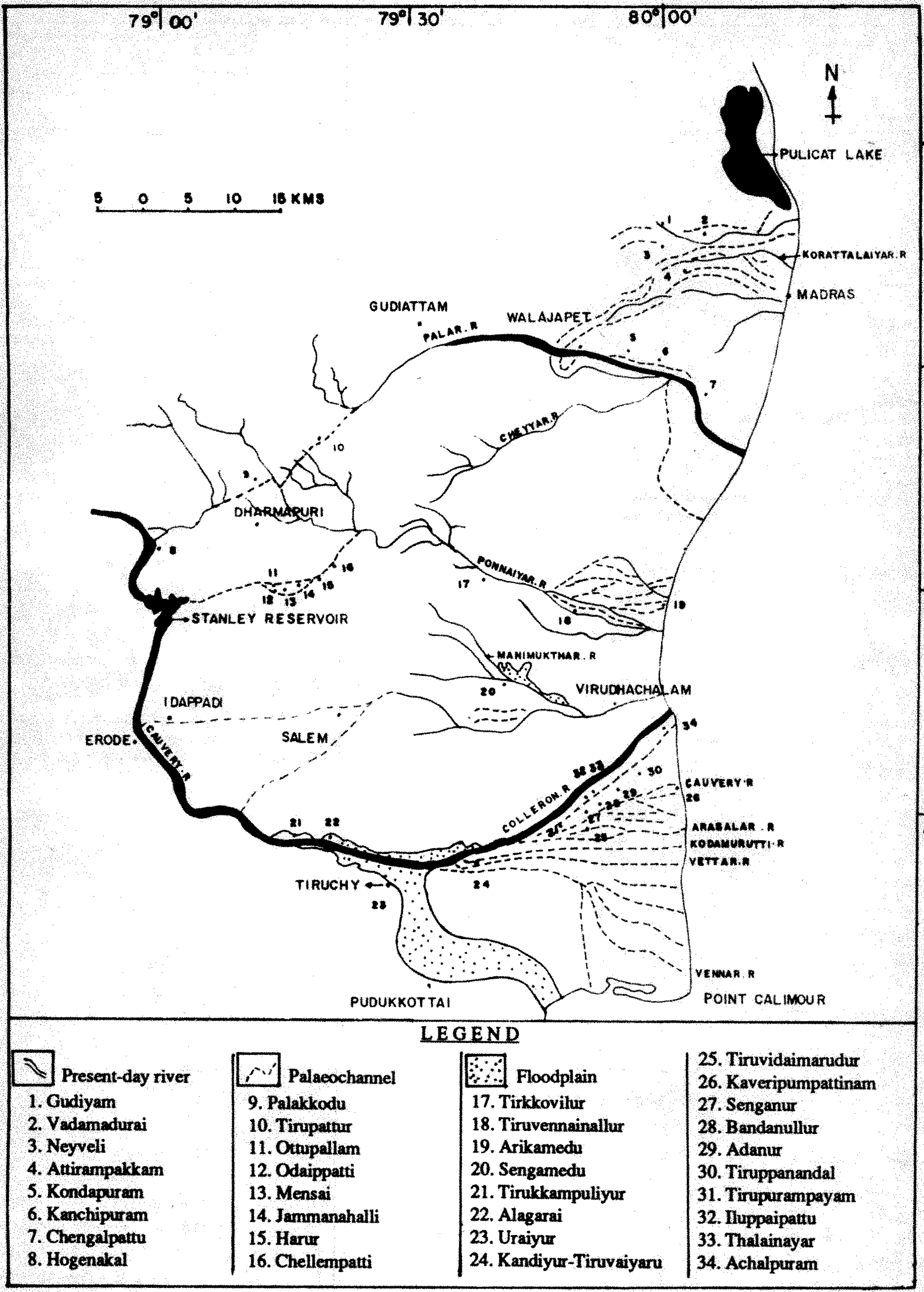


Fig. 4: Periods of river migration in Tamil Nadu

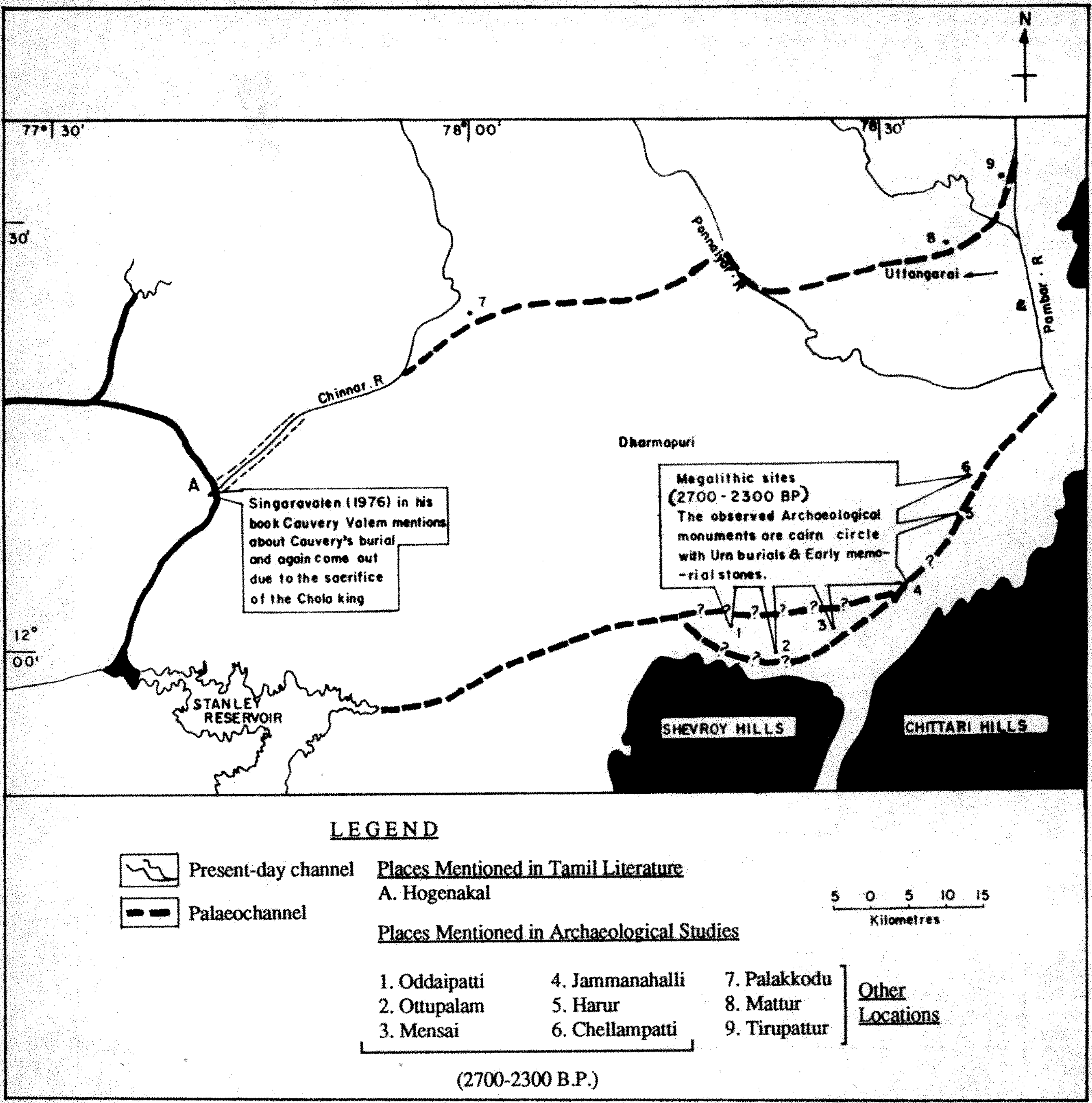


Fig. 5: Palaeochannel network of Dharampuri-Stanley Reservoir region

Tiruchy-Thanjavur Region

Of all the Tamil Nadu river systems, the Kaveri delta reveals the most spectacular network of palaeochannels (Figs. 4,9, 10 and 11). Interestingly, all the palaeochannels are found only to the south of the present-day Kaveri/Colliroon (Kollidam) rivers. The southernmost set of palaeochannels occur in the Tiruchy-Kiranur-Pudukkottai region. These palaeochannels are all contained within the floodplain which is 5-7 km wide in the Kiranur-Pudukkottai area. This floodplain/palaeochannel system is currently superposed by the Agniyar, Ambuliyar and Vellar river systems (Fig. 9). A similar palaeochannel network forms a distributary network in the Kaveri delta and these palaeochannels are superposed by the Vennar, Vettar, Kodamurutti, Arasalar and Kaveri. The Vennar is the southernmost and the Kaveri the northernmost finger of this bird foot-shaped delta. There is also a wide palaeochannel between the Kaveri and the Kollidam rivers in the Kumbakonam-Achalpuram region (Figs. 4 and 9).

Ramasamy (1990) has observed signatures of younger

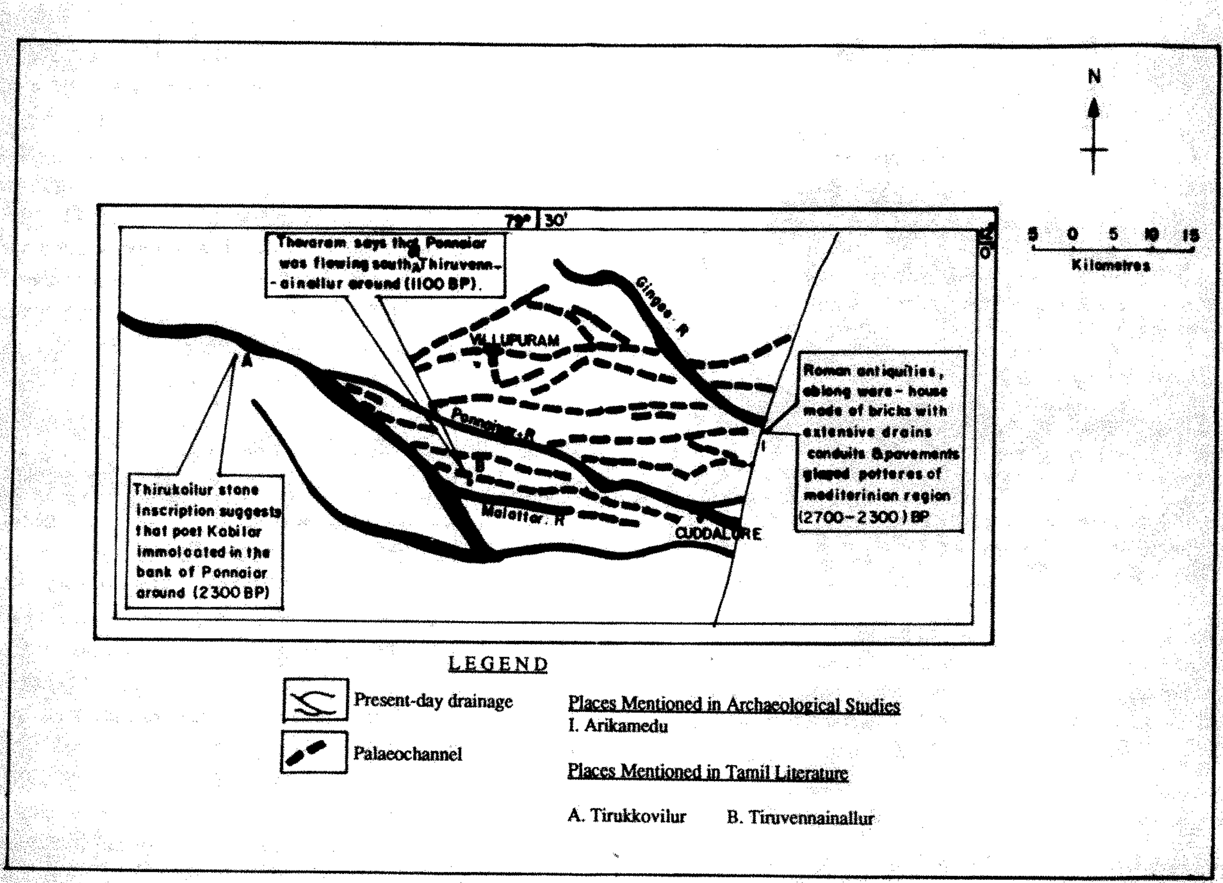

N
5 0 5 10 15
Kilometres
79° 30'
12° 0'
Thevaram says that Ponnaiar was flowing south Thiruvennainallur around (1100 BP).
VILLUPURAM
Ginges. R
Ponnaiar. R
Malattar. R
CUDDALORE
A
B
I
Roman antiquities, oblong ware-house made of bricks with extensive drains conduits & pavements glazed potteres of mediterinian region (2700-2300) BP
Thirukoilur stone inscription suggests that poet Kobilar immolocated in the bank of Ponnaiar around (2300 BP)
LEGEND
Present-day drainage
Palaeochannel
Places Mentioned in Archaeological Studies
I. Arikamedu
Places Mentioned in Tamil Literature
A. Tirukkovilur
B. Tiruvennainallur

Fig. 6: Palaeochannel network of Thirukovilur-Villupuram region

floodplains along the Vennar-Vettar-Kodamurutti-Arasalar-Kaveri river systems (Fig. 10) and has suggested that the presence of a younger floodplain along the old channels is due to the rejuvenation of these palaeochannels time and again during floods in the Kaveri. He has further suggested that the Kaveri once flowed via Kiranur and Pudukkottai to meet the sea in the area where the present-day Agniar and Ambuliar meet the sea (Ramasamy 1991). Subsequently it underwent an anticlockwise rotational migration and after flowing along the present-day tracts of the Vennar, Vettar, Kodamurutti, Arasalar and present-day Kaveri, it has stabilised as the Kollidam.

Rivers and Archaeology

This study represents a first attempt to integrate the evidence for archaeological sites with the palaeochannel map of Tamil Nadu.

Madras Region

The first palaeolithic site near Attirambakam (Attirampakkam) (4 in Fig. 2), along the banks of the Kortalayar nallah, was discovered by Robert Bruce Foote in 1864. Many years later Krishnaswamy (1934) initiated and completed an intensive field survey of the area for Megalithic monuments. Attirampakkam, Vadamadurai, Neyveli, Gudiyam and Poondi (1,2,3,4,5 in Fig. 4) are all situated in the present-day Kortalayar basin/palaeo-Palar region. Archaeological remains from these sites have been dated to the Palaeolithic period. Foote (1864), Krishnaswamy (1934) and Ramachandran (1980) have explained that the archaeological remains were observed in a lateritic gravelly horizon overlying Boulder Conglomerates which in turn overlie the Upper Gondwana shales.

In addition, Krishnaswamy (1934) has observed that the Boulder Conglomerate which is of Lower Pleistocene age is intensely dissected and forms three terraces at 20m, 7m and 2.5m above the present-day river. The archaeological remains excavated from Attirampakkam, Vadamadurai, Neyvelli, Gudiyam and Poondi have invariably been collected from these river terraces. This shows the presence of prehistoric cultures from the Acheulian period to 10,000 years ago, and are referable to the Lower, Middle and Upper Palaeolithic period or the Pleistocene period. Ramachandran

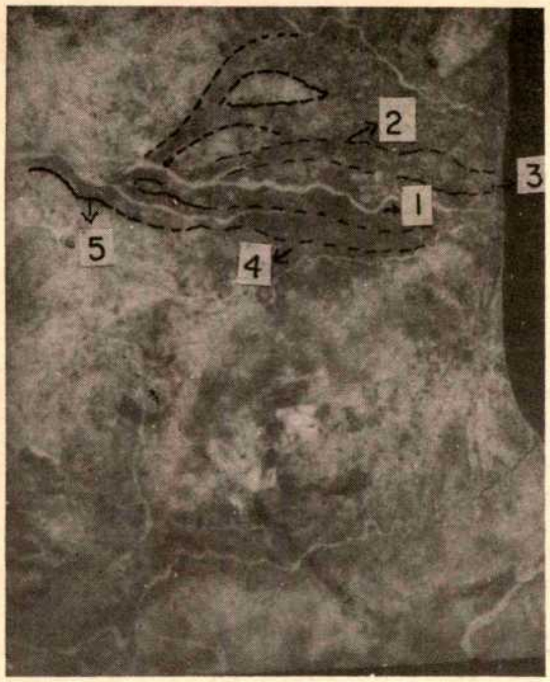


Fig. 7: Satellite picture showing palaeochannels in Attur-Chidambaram region 1. present-day Ponnaiyar 2. old course of Ponnaiyar which was meeting the sea near Arikamedu 3. Arikamedu 4. a distributary of Ponnaiyar terminating near Thiruvennai nallur 5. Thiruvennai nallur

(1980) has further mentioned that the archaeological remains indicate that the culture of prehistoric man at Kortalayar was chronologically co-eval with that of Narmada man.

Dharmapuri Region

In the Dharmapuri region, archaeological remains observed in close proximity to palaeochannels in Oddaipatti, Ottupalam, Mensai, Jammanahalli, Harur and Chellampatti (Fig. 5) can be assigned to the Megalithic period dated to 2700-2300 years B.P. as suggested by Rajan (1991) and Ramachandran (1980). They reported several archaeological remains such as cairn circles and urn burials, which according to them indicate the existence of a river-based culture which flourished during the Megalithic period. While such archaeological remains along the Ottupalam-Chellampatti palaeochannels give an age of 2700-2300 years B.P. to the palaeochannel which connects the Kaveri with the Ponnaiyar, the palaeochannel connecting the Kaveri with the Palar between Hogenekal and Tirupattur could not be dated as no archaeological evidence has been discovered here yet. Therefore, at present it can only be surmised that the Kaveri would have joined the Palar prior to 2700 years B.P., and would have flowed along the present-day Ponnaiyar's course between 2700-2300 years B.P.

Tirukkovilur-Villupuram Region

Arikamedu (Fig. 6, 19 in Fig. 4) which is located at the mouth of one of the distributaries of the Ponnaiyar revealed evidence of Roman culture (an oblong warehouse made of bricks with extensive drains, conduits and a pavement, glazed pottery of Mediterranean origin, etc.) as well as architectural remains of the Megalithic period (2700-2300 years B.P. (Wheeler 1946; Ramachandran 1980). A study of the archaeological data shows that the ancient port towns and sea shore civilizations were confined to the river mouths only suggesting that there might have been a mighty river system near Arikamedu between 2700 and 2300 years ago. This fact evidently suggests that the river Kaveri which was flowing via Uttangarai and Tirukkovilur would have joined the Bay of Bengal, forming well-developed distributaries of which one met the sea near Arikamedu. Satellite pictures also show clear palaeochannels.

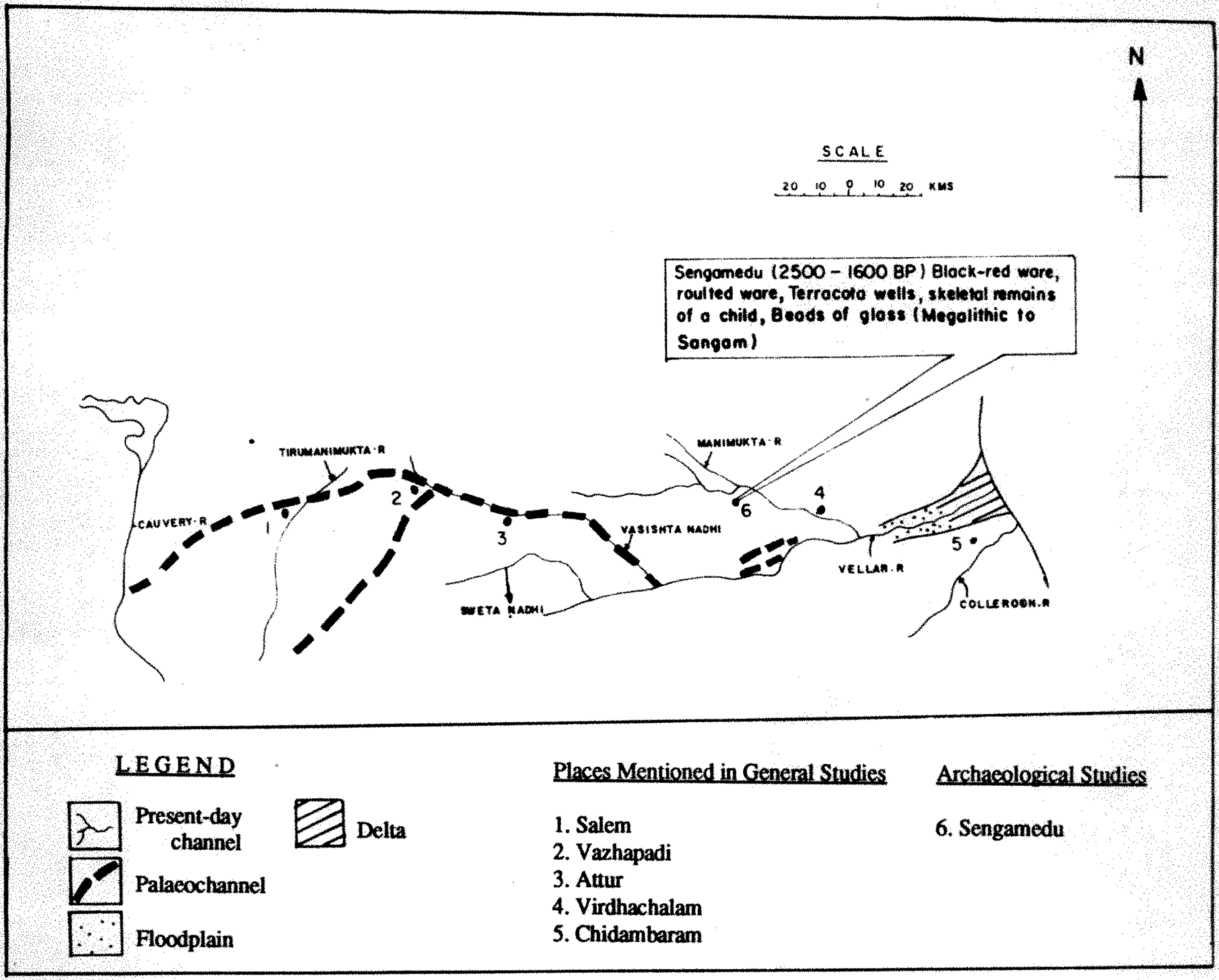
Salem-Attur-Chidambaram Region

The archaeological remains from Sengamedu , e.g. Black and Red ware, Rouletted ware, terra cotta wells, skeletal remains of a child, etc. as described by Ramachandran (1980) and others suggest that at Sengamedu human settlements began around 2700 years B.P. and lasted up to 1600 years B.P. (Megalithic period to the Sangam Age). Certain cultural elements with Roman influence observed at Arikamedu are also found in Sengamedu. Ramachandran (1980) has suggested that these would have first reached Arikamedu and then been gradually transmitted through trade to Sengamedu. Interestingly, satellite images show a clear-cut palaeo-shoreline at Mannargudi and Tiruvidaimarudur and up to 4 kms west of Chidambaram (Fig. 8). If that is the case, the sea might have been not more than about 5 kms from Sengamedu in the recent past. Therefore, it may not be that far-fetched to imagine an independent riverine port near the meeting point of the Manimukta and Vellar rivers and an inland water transport system going right up to Sengamedu. If this was so, then the Roman culture would have independently come to Sengamedu. However, the Sengamedu civilization suggests that the Manimukta might have undergone turbulent fluvial activity during the period from 2700-1600 years B.P.

It is significant to observe that Sengamedu is located on the widespread floodplain of the Manimukta river (Fig 8).

Tiruchy-Thanjavur Region

Archaeological remains from Tirukampuliyur (21 in Fig. 4) which is located on the floodplain of the Kaveri can be ascribed to three phases — 2300 to 1800 years B.P.; 1800 to 1400 years B.P.; and the period after 1400 years B.P. Similar phases are also observed at Alagarai (22 in Fig. 4). Ramachandran (1980) assigns these sites to the period dating from the Megalithic to the Sangam Age. From Uraiyur (23 in Fig. 4) which was the capital of the Cholas during the Sangam Age, there is also evidence to suggest three archaeological



Sengamedu (2500 – 1600 BP) Black-red ware, roulted ware, Terracota wells, skeletal remains of a child, Beads of glass (Megalithic to Sangam)

Fig. 8: Palaeochannels of Salem-Attur-Chidambaram region

stages: 2000 to 1800 years B.P.; 1800-1400 years B.P.; and the period after 1400 years B.P., whereas the evidence from Kaveripumpattinam suggests an age of 2500 to 1600 years B.P. (Ramachandran 1980). Alagarai, Tirukkampuliyur and Uraiyur are all located on the floodplain of the Kaveri (Fig. 9) and hence it can be concluded that the Kaveri would have flowed up to Thirukkampuliyur and Alagarai during the Megalithic period.

Kaveripumpattinam (Poompuhar) (26 in Fig. 4), which is located at the point where the Kaveri meets the Bay of Bengal, was also a capital city of the Cholas. Archaeological remains for the site also are of the Sangam Age with a minimum age of 2500 years B.P. for Kaveripumpattinam.

Rivers and Tamil Literature

Ancient Tamil literature contains considerable information about old river systems. When this information is correlated with the geographical location of the present-day river systems, it suggests that these rivers have changed their courses. This fact has been well established by the present study of the Kortalayar, Palar, Ponnaiyar and Kaveri basins.

Madras Region

The historical synthesis of the Tamil Nadu Historical Society (1975) shows that the region north of Madras, the Kortalayar region, was well-drained in the Vadamadurai region. There is evidence of thick clay sediments overlain by a lateritic gravelly bed which in turn is overlain by clays, sands and lateritic soils. It has also been observed that the river terraces occur at an elevation of 100m above the present-day river bed in the Kortalayar valley. Krishnaswamy (1947) has described a stratigraphic cross-section comprising a boulder conglomerate which has been dissected to form three terraces, one at the height of 20m, the second at 7 m and third at 2.5 m above the present bed of the Kortalayar. This evidence clearly suggests that a major river might have flowed through this region (Fig. 2) during the Pleistocene.

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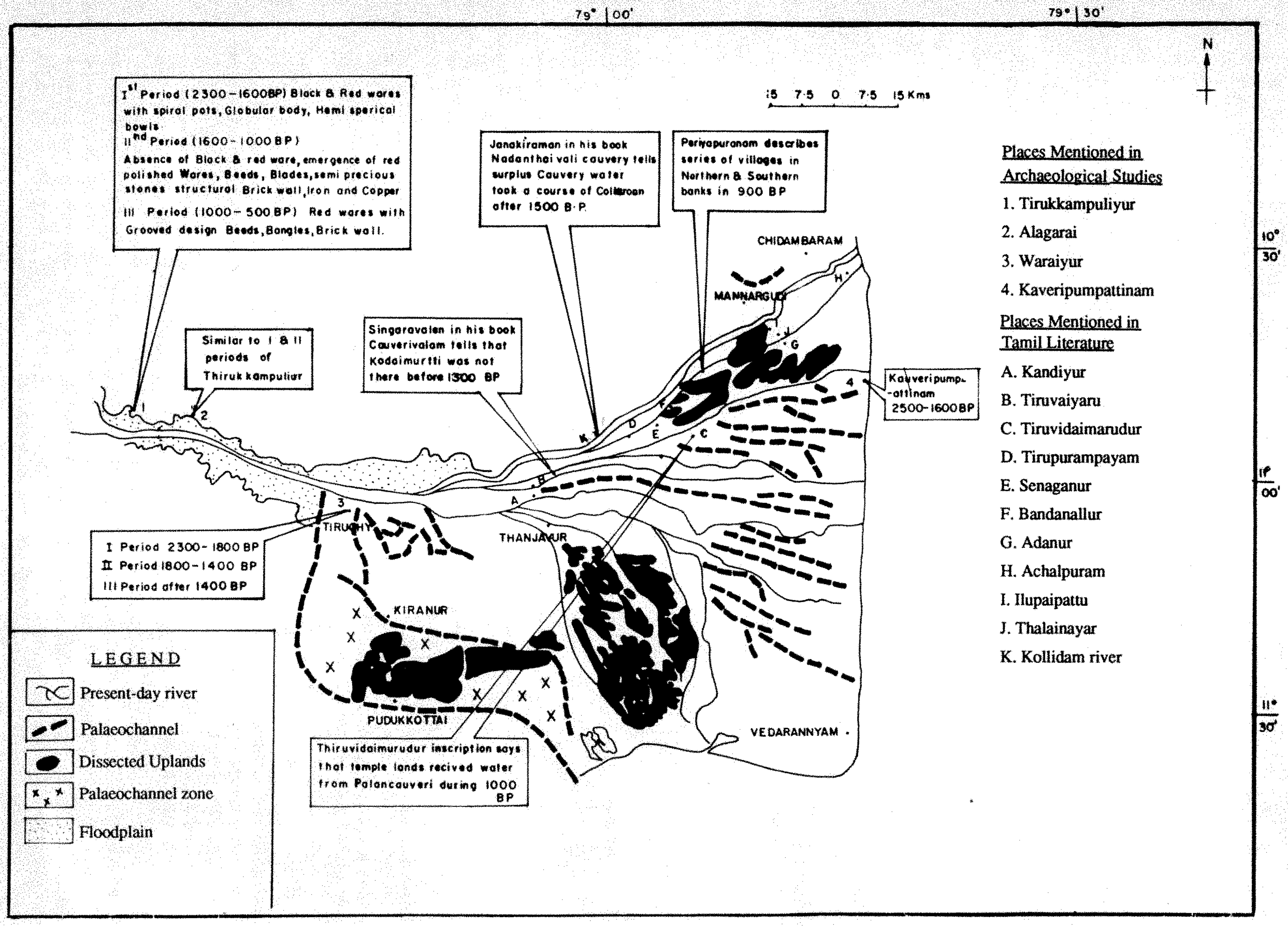

I^st^ Period (2300 - 1600BP) Black & Red wares with spiral pots, Globular body, Hemi sperical bowls
II^nd^ Period (1600 - 1000 BP)
Absence of Black & red ware, emergence of red polished Wares, Beeds, Blades, semi precious stones structural Brick wall, Iron and Copper
III Period (1000 - 500 BP) Red wares with Grooved design Beeds, Bangles, Brick wall.

Similar to I & II periods of Thirukkampuliur

Singaravalen in his book Cauverivalam tells that Kodaimurtti was not there before 1300 BP

Janakiraman in his book Nadanthai vali cauvery tells surplus Cauvery water took a course of Collidam after 1500 B.P.

Periyapuranam describes series of villages in Northern & Southern banks in 900 BP

Kaveripumpattinam 2500-1600BP

I Period 2300 - 1800 BP
II Period 1800 - 1400 BP
III Period after 1400 BP

Thiruvidaimurudur inscription says that temple lands recived water from Palancauveri during 1000 BP

Places Mentioned in Archaeological Studies
1. Tirukkampuliyur
2. Alagarai
3. Waraiyur
4. Kaveripumpattinam

Places Mentioned in Tamil Literature
A. Kandiyur
B. Tiruvaiyaru
C. Tiruvidaimarudur
D. Tirupurampayam
E. Senaganur
F. Bandanallur
G. Adanur
H. Achalpuram
I. Ilupaipattu
J. Thalainayar
K. Kollidam river

Fig. 9: Palaeochannel network of Tiruchy-Thanjavur region

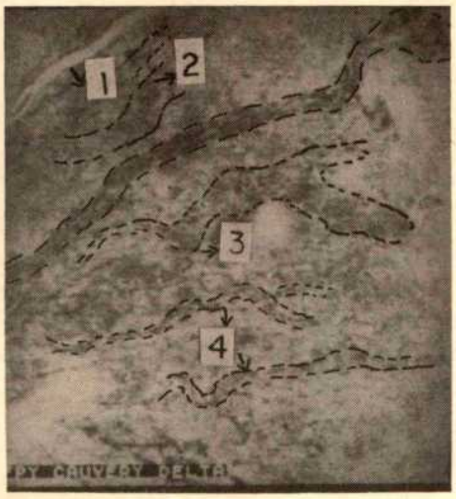

Fig. 10: Satellite picture showing palaeochannels in the northern part of the Kaveri delta 1. Kollidam river 2. old course of Kaveri which is said to have flown during Periyapuranam time 3. old course of Kaveri which is currently called Arasalar 4. palaeochannel of the Vennar and Vettar

In ancient Tamil literature, Jayamgondar, author of the *Kalingthuparani* has stated that the army of king "Karunakara Thondaiman" crossed the Palar river while proceeding northwards from their capital city, Kanchipuram (6 in Fig. 4). Currently, however, the Palar flows south of Kanchipuram (B in Fig. 2). This fact has also been cited by Lena Tamilvannan (1988) for North Arcot District. All this indicates that the Palar river must have flowed north of Kanchipuram around 1100 years B.P. which is the period of Karunakara Thondaiman's reign. Inscriptions in the Kondapuram temple (A in Fig. 2) also indicate that the Palar flowed north of the temple while presently it flows south of the temple.

Raghavan (1978) in his book *Ptolemy* has mentioned that during Ptolemy's period (1800 years B.P.) the Palar flowed very close to Chengalpattu (7 in Fig. 4), though currently, it flows 3-5 kms west of it. The interpretation of satellite data shows a lot of meander scars in the Palar, west of Chengalpattu (Fig. 2). This indicates that the Palar which was meandering in the Chengalpattu region would have straightened out its course probably consequent on the fall of sea level in this region. But interestingly, Ptolemy's period is 1800 years B.P. But on the contrary during Karunakara Thondaiman's period, the Palar is said to have flown north of Kanchipuram. Hence it can be concluded that, Palar might have originally flown along the present-day Kortalayar valley from the middle Pleistocene and latest up to 1800 years B.P. But in its end phase (i.e. around 200 years B.P.) it would have drifted and taken the Chengalpattu course.

But what Karunakara Thondaiman's army has crossed north of Kanchipuram during 1100 years B.P. might have been the old course of the Palar which must have been

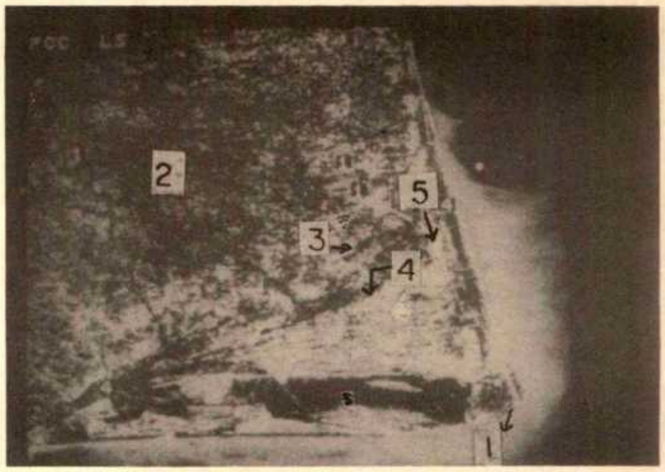

Fig. 11: Satellite picture showing palaeochannel in the Kaveri delta 1. Point Calimere 2. old course of Kaveri 3. Tiruthurai poondi 4. ancient strandline 5. beach ridges

getting surplus water from the Palar which has migrated towards Chengalpattu from the Madras tract. In other words, it can be surmised that from 1800 to 1100 years B.P., the Palar might have flowed as two streams, one towards Madras and the other towards Chengalpattu with the Chengalpattu branch as the main one and the Madras branch as the subordinate one. The reason for such an overall southerly migration of the Palar was attributed to the rise of land in the Kortalayar valley as demonstrated by Ramasamy *et al.* (1987).

Dharmapuri-Stanley Reservoir Region

In his *Cauverivalam*, Singaravelan (1976) has mentioned an old story about the Kaveri 'disappearing' near Hogenakal (A in Fig. 5) and of how a holy Chola King sacrificed his life so as to cause the river to re-appear. This is supposed to explain why the Kaveri re-appeared and started to flow towards the Thanjavur plains which was the kingdom of the Cholas. Though Singaravelan did not mention any specific period for this incident, it is interesting to note that the Kaveri river, which met the Ponnaiyar has changed its course towards Erode only from this point, i.e. from Hogenakal.

Tirukkovilur-Villupuram Region

The Tirukkovilur temple's stone inscription states that the ancient poet Kabilar left king Party's/Pary's daughter on the bank of the Ponnaiyar river and then immolated himself. The incident, as per the inscription, is ascribed to 2300 years B.P. which is also the period of Kabilar, and it follows from this that the Ponnaiyar existed in this region during that period. It may therefore be deduced that from 2700 to 2300 years B.P., the Kaveri flowed along this tract and subsequently, from 2300 years B.P. onwards, the Ponnaiyar would have flowed along this course.

Tiruchy-Thanjavur Region

Several authors and inscriptions refer to the old river systems in the deltaic regions of the Kaveri. For example, Singaravelan (1976) states that the Kodamurutti river did not exist prior to the 7th century and its disappearance must therefore date to less than 1300 years B.P. (A in Fig. 9).

An inscription in the Mahabalisvarar temple at Tiruvidaimarudur states that the temple's agricultural lands were watered by a stream called the 'Palankaveri'. Currently no stream exists suggesting, that around 1000 years B.P., which was the age of the inscription, the Kaveri probably flowed close to Tiruvidaimarudur (C in Fig. 9).

Veerasamy, the author of *Periyapuranam* (1990) mentions numerous places like Thirupurampayam (Tirupurambiyam) (D), Sengannur (E), Bandanallur (F) and Adanur (G) on the southern bank of the Kaveri river and others like Achalpuram (H), Illuppaipattu (I) and Thalainayar (J), all on the northern bank (Fig. 9). However, the reconstruction of the said river systems on the basis of their regional geographical locations reveals a palaeochannel and hence a mighty river might have flowed from 900 years ago which was the period of the author of the *Periyapuranam*.

Janakiraman (1971) in his book *Nadanthai Vazhi Kaveri* has mentioned that about 750 years ago (K in Fig. 9) due to floods in the Kaveri the excess water took a new channel in the name of the Kollidam. The archaeological remains of Tirukampuliyur, Alagarai and Uraiyur region assign an approximate age of 2300-1600 years B.P. to the Kaveri river. Singaravelan (1956) in his book *Cauvery Valem* has mentioned that the river Kodamurutti did not exist prior to 1300 years B.P. This fact leads to the conclusion that the river Kaveri might have flowed from Tiruchy, Kiranur and Pudukkottai and met the Bay of Bengal where the Agniyar and Ambuliar meet the Bay of Bengal today and subsequently drifted towards the present-day path of the Vennar and Vettar during the period from 2300-1600 years B.P. The Kaveri would have flowed as the Kodamurutti only after 1300 years B.P. as revealed by Singaravelan (1976).

The Tiruvidaimarudur inscription shows that the temple lands received water from the Palankaveri around 1100 years B.P. Although there is no active river system there, well developed palaeochannels have been seen on the satellite photos. This leads to the conclusion that the river Kaveri which was flowing as the Kodamurutti around 1300 years B.P. would have changes the course and would have flowed north of Tiruvidaimarudur around 1100 years B.P. In the *Pariyapuranam* the author states that geographical locations like Senganur (27), Bandanallur (28), Adanur (29), Tiruppanandal (30) formed the southern bank of the Kaveri and places like Tirupurambiyam (31), Eluppaipattu (32), Thalainayar (33) and Achalpuram (34) (all in Fig. 4) were located on the northern banks of the river. Currently there is no river in this area though clusters of palaeochannels have been observed in the satellite imagery of this region. This shows that the Kaveri river which was flowing as the Palankaveri north of Thiruvidaimarudur around 1100 years B.P. would have migrated towards the north and flowed along this tract around 900 years B.P. which is the period of the *Periyapuranam*.

While the archaeological and Tamil literature data suggest a sequential migration of the Kaveri river from Kiranur to the Kumbakonam-Achalpuram tract, the river Kollidam tells a different story. Maclence (1902) in the *Tiruchy District Gazetteer*, wrote that the river Kollidam would have originated 1500 years ago due to the excessive flooding in the river Kaveri. Janakiraman (1971) in his book also mentioned that the Kollidam is the branch-away channel of the river Kaveri resulting from major floods. But the undoubted anticlockwise rotational migration of the Kaveri from the Agniar-Ambuliar tract to the present-day Kollidam, clearly shows that the river once flowed along the present-day Agniar-Ambuliar channel and gradually shifted and began to flow along the Vennar, Vettar, Kodamurutti, Arasalar and Palankaveri streams and finally stabilised as the Kollidam river. Amongst these migratory arms the Kodamurutti is dated to less than 1300 years B.P. and old channels found south of the Kollidam are dated to around 900 years B.P. (*Periyapuranam* age). The Kollidam therefore, must be younger than 900 years B.P. This suggests that the river Kaveri would have flowed along the present-day Agniar-Ambuliar tract around 2300 years B.P. and gradually reached the Kollidam stage after 900 years B.P. In this context the age of Kaveripumpattinam needs detailed study.

Conclusions

The interpretation of palaeochannels from satellite images and the integration of this data with that from Tamil literature and archaeology shows that:

1. The Palar river flowed in a northeasterly direction to meet the sea during the period from at least Pleistocene to 1800 years B.P. and that it has followed alone its present course from 1800 years B.P. onwards. However, the pattern and orientation of the palaeoflow of the Kaveri in the Dharmapuri region suggests that the Kaveri might have met the river Palar from the Stanley Reservoir via Chinnar, Palakodu, Mattur and Tirupattur. Therefore, it was not the Palar which flowed through the Kortalayar valley but only the Kaveri. Furthermore the latter might have flowed from Pleistocene to 2700 years B.P. in the Kortalayar valley after which it would have abandoned that course and started flowing via the present-day Ponnaiyar. The Palar river, on the other hand, would have started flowing along the abandoned course of the Kaveri after 2700 years B.P. or after 1800 years B.P.

2. The Kaveri river probably flowed along the present-day Ponnaiyar course from 2700 years to 2300 years B.P.
3. The Kaveri would have shifted from the Ponnaiyar's course and reached the Tiruchy region around 2300 years B.P. Between 2300-1300 years B.P. it flowed along the tracts of the Kiranur-Pudukkottai and modern Vennar and Vettar, then along that of the Arasalar and Palankaveri around 1300-1100 years B.P., along the channel of the Kumbakonam-Achalpuram around 900 years B.P. and finally stabilised as the Kollidam after 900 years B.P.
4. The palaeochannel which connects the Kaveri with the Manimukta river along the Attur needs to be dated. However, it probably briefly flowed around 2300 years B.P.
5. In the light of the evidence emerging from the present study all the palaeochannels mentioned should be investigated for archaeological remains, placer mineral deposits and groundwater reservoirs.
6. Dating of the palaeochannel sediments by thermoluminiscence and C^{14} will throw more light on the migratory history of the rivers of Tamil Nadu.

Acknowledgements

The authors are grateful to the Indian Space Research Organisation (Bangalore) which has funded this study under the RESPOND programme. Cartographic assistance by Shri M. Ravichanadran and secretarial assistance by Shri T. Punniamoorthy are acknowledged.

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Possible Palaeoclimatic and Climatostratigraphic Significance of the Conglomerates of the Upper Bakhtiari Formation, Foot Hill Zone of Iraq

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Abstract

This paper uses an amalgam of data obtained from regional geological mapping and preliminary palaeomagnetic investigations to stress the importance of the palaeoclimatic factor in the accumulation of the conglomerates of the Upper Bakhtiari Formation (and its counterparts) in Iraq and the adjoining areas. The results suggest that a related pluvial phase commenced around 2.47 Myr ago i.e., shortly after the Matuyama/Gauss boundary, and is thus coeval with the important palaeoclimatic threshold found in other parts of the world. This, if correctly interpreted, may potentially prove valuable for choosing the Pliocene/Pleistocene Boundary for continental sequences of the Middle East.

Introduction

Two major obstacles are encountered when examining the stratigraphy of the Quaternary system in the Middle East: the first is the lack of sufficient chronological data and the second is the poverty of palaeoclimatic information. This situation is not only a handicap to the elaboration of local stratigraphic schemes but hinders regional and global correlations as well. This paper emphasizes a poorly understood aspect of the Pliocene/Pleistocene sequence, i.e. the possible palaeoclimatic significance of the Upper Bakhtiari Formation conglomerates of the Foot Hill Zone of Iraq and their local and regional counterparts (Fig. 1), in an attempt to facilitate an understanding of the Quaternary record of the Middle East, an area that at present is a gap on the Pleistocene map of the world.

The Upper Bakhtiari Formation (U.B.F.) Conglomerates: Definition and Regional Distribution

A massive fluvial conglomeratic formation from southwest Iran, Khozestan Province was recognized in the early part of this century and was described by Pilgrim (1908). It was termed the Upper Bakhtiari Formation, though in Iran it was later known as the Bakhtiari Formation (James and Wynd 1965). The formation in its type locality is divided into two parts: the lower one is an alternation of massive conglomerates, sandstones and gritstone, while the upper part is composed of very massive conglomerates with sandstone lenses. The gravel is composed mostly of limestone and chert. Depending on its stratigraphic position,the age of the formation is considered to be Late Pliocene-Pleistocene (Stocklin and Setudehnia 1971). In north Iran, and on the

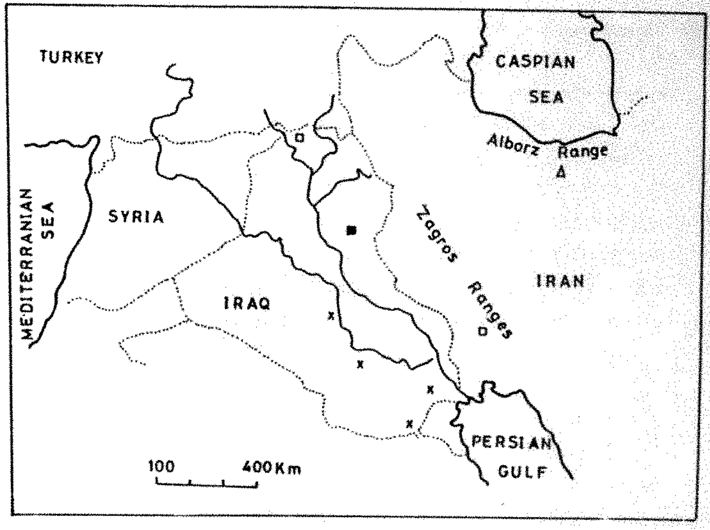

Fig. 1: Location of the sediments studied and their equivalents:
■ = Palaeomagnetically investigated section of the U.B.F.
□ = The U.B.F. of the Zakho Basin, north Iraq and Kozestan Province, Southwest Iran
△ = Hezarderrah Formation, North Iran
X = Dibdiba Formation

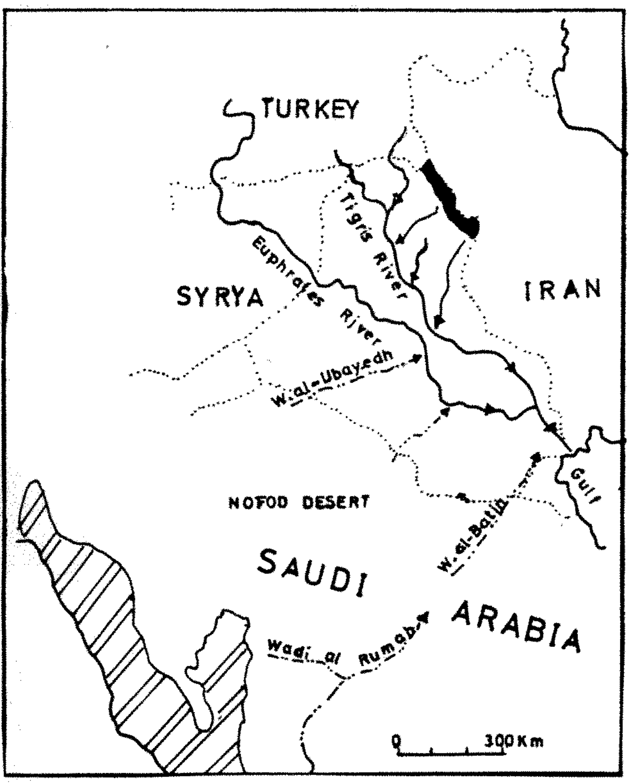

Fig. 2: Present-day configuration of the major drainage elements in Iraq:

↝ = Perennial water courses
⇢ = Ephemeral water courses — wadis
▬ = Provenance of the igneous-metamorphic-chert type of gravels of the U.B.F.
▨ = Crystalline basement of Saudi Arabia, the source of clastics of Dibdiba Formation

southern slopes of the Alborz Mountains, between Qazwin and Shahrud, massive conglomerates with minor intercalations of sandstones and mudstones were termed the Hezardarreh Formation (Rieben 1955), and were considered to be equivalent to the Bakhtiari Formation of the southwest. In Iraq the same Bakhtiari Formation was described and mapped, but its former name, i.e., U.B.F., is still retained (Van Bellen *et al.* 1959; Buday 1976). In the Foot Hill Zone of Iraq the formation is composed of massive conglomerates with lenticular sandstones. The composition of the gravels, in order of abundance, is carbonates, cherts and metamorphic as well as igneous materials. The chert was found to be radiolarian and hence its source is the Qulqula Radiolarian Chert Series of northeast Iraq (Lateef 1976). This northeastern provenance is corroborated by the igneous and metamorphic components and by the established palaeocurrent directions (Lateef 1976).

In the High Folded Zone of north Iraq, the formation is represented by massive conglomerates. In one segment of this zone, namely the Zakho Basin (north of Bekhair Mountain), the formation is composed of two members (Lateef 1977): the lower one is represented by an alternation of thick conglomeratic "ribs" and mudstone, i.e., alternation of lateral accretion and vertical accretion deposits, while the upper member is composed of very massive conglomerates with sandstone lenses. West of the Zakho Basin, i.e., in northeast Syria, the conglomerates described by Ponikarov *et al.* (1967) are possibly the extension of the Bakhtiari Formation west of the Phishkhabour area. In south Iraq the Upper Bakhtiari Formation passes facially into the red conglomerates, gravelly sandstones and sandstones of the Dibdiba Formation which also extends into the western and northwestern parts of Kuwait and northeast Saudi Arabia.

The Genesis and Possible Climatic Significance of the Distal Parts of the U.B.F. Conglomerates

Consideration of the Field Evidence: The accumulation of this huge conglomeratic unit has been attributed to the "uplifting and subsequent erosion" of the mountain ranges in the paroxysmal phases of the Alpine Orogeny (Van Bellen *et al.* 1959). This explanation has been upheld since then by all subsequent authors (e.g., James and Wynd 1965; Stocklin and Setuhdenia 1971; Buday 1976) without any elaboration on the processes involved. However, the criteria for "uplifting", without the identification of the conditions for the "subsequent erosion", cannot satisfactorily account for the restriction of these conglomerates to a "Pliocene-Pleistocene" datum. Indeed, it is evident that in a vertical profile the appearance of coarse clastics may be initiated by: 1) tectonic effects through uplifting and rejuvenation of relief in the source area and 2) palaeoclimatic changes. Surprisingly, in the case of the U.B.F. conglomerates the concept of climatic change was overlooked or ignored. Thus, in order to deciphere the role of climatic variations, if any, in the process of the formation of this detritus, it is necessary first to examine the site of accumulation within the palaeogeographic — tectonic setting of the Mesopotamian Geosyncline trough. The spatial distribution of these deposits points to a considerable distance between provenance and the basin of deposition (Fig. 2), where the chert, igneous and metamorphic components (that constitute about 50% of the total population) indicate a source as far to the northeast as the Qulqula Radiolarian Chert Series and the igneous-metamorphic complex of the Bulfat-Mawat-Penjwin Zone. Such a widespread and far inland configuration which occurs in some segments, hundreds of kilometres from the source, differs from other molasse conglomerates in other parts of the Alpinian belt such as the Siwalik Group of India, where it is restricted to a relatively thin belt of 20-25 km width parallel to the Lesser Himalaya, or the Alpine Miocene conglomerates of the Jura mountains which are confined to fans on both sides of the Alps. On the other hand, if the tectonic factor is considered to be the cause of the accumulation of this detritus (as is emphasized in the available literature), and if we recall that the current altitudinal aspects of the Zagros ranges have been attained since Late Tertiary times (Lees 1955), then there should have occurred other

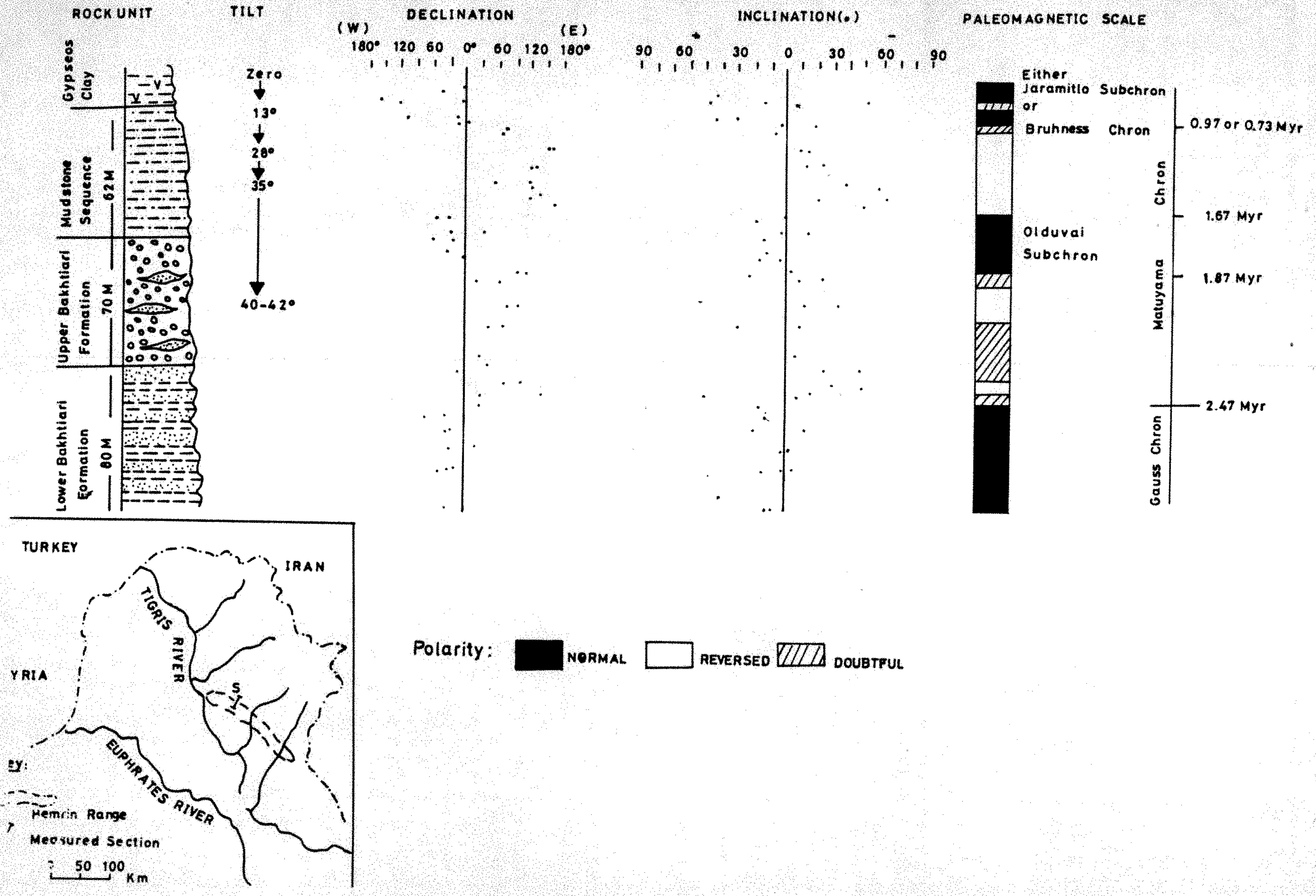

Fig. 3: Tentative magnetostratigraphy of the Late Neogene-Quaternary sediments of the Jebel Hemrin structure of the Foot Hill Zone of Iraq (partially modified after Lateef 1979; Lateef and Hus 1981)

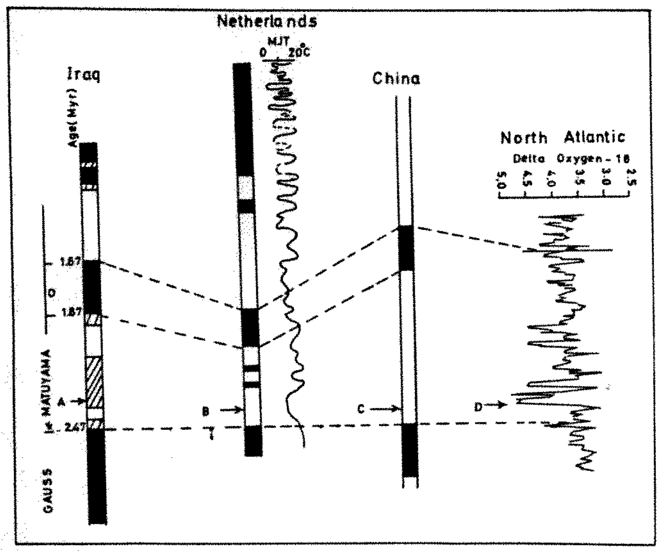

Fig. 4: Comparison of the palaeoclimatic threshold shortly after the Gauss-Matuyama Boundary from four selected areas:

A = Commencement of the pluvial phase
B = The first cooling in the northwest Europe, i.e. the base of the Praetiglian Stage (Zagwijn 1957 and 1985)
C = Loess deposition in China, i.e. Wucheng loess (Tungsheng *et al.* 1985)
D = The onset of ice rafting in the North Atlantic region (Shackleton *et al.* 1984)
O = Olduvai Subchron
MJT = Mean temperature of July
Legend of polarity is that of Fig. 3.

conglomeratic manifestations from the Pliocene-Pleistocene threshold, through the Pleistocene and up to recent times. However, this is not the case where neither the post-U.B.F. record nor the present-day drainage system show any evidence or capability of producing conglomeratic distributions, in time and space, similar to those of the U.B.F. Therefore, this conglomeratic formation, constrained by such a datum line, requires appropriate conditions for its deposition, apart from the tectonic concept of uplift. This suggests a period of exceptionally high run-off and a widespread discharge pattern of a perennial fluvial system, as evidenced by the observed imbrication and preferred orientation of the constituent gravels. Thus it may be inferred that the stream regime responsible for the deposition of these conglomerates has been characterized by enormous transporting kinetic energy and might be pictured as an extensive mosaic of braided-anastomizing palaeo-river systems resulting in the overwhelming deposition of lateral accretion (channel lag) deposits. It is evident that the above mentioned high palaeo-river dynamism (high water discharge) and its sediment-chocked character can be attributed to a specific palaeoclimatic setting as will be suggested later.

Interpretation of the Palaeomagnetic Data

In the first magnetostratigraphic study in Iraq some preliminary but important results were obtained (Lateef 1979; Lateef and Hus 1981). In Fig. 3 the palaeomagnetic polarity sequence for the Late Neogene-Quaternary deposits of the Foot Hill Zone of Iraq, Hemrin North Range, is shown, where in addition to the obtained absolute chronology of these undated continental deposits, there is another interesting result, i.e. the obvious correlation between reversals and changes of lithologic composition (size of clastics) for all three stratigraphic boundaries of the section. Previous research (Bucha 1976, 1977; Morner 1978, 1979) emphasized the relationship between changes of the earth's magnetic field and changes in weather and climate. This "link" between climate and the behaviour of the earth's magnetic field, as indicated in the Holocene record, can also be inferred from the stratigraphic evidence for the 500-2500 year climatic cycles (Paepe *et al.* 1984) and the observed similar periodicities of the magnetic field fluctuations (Creer 1981; Thouveny *et al.* 1985). However, the effect of changes in the geomagnetic field on atmospheric circulation is not yet well understood.

Thus, by accepting the fairly well established impetus of exogenetic effects on climate, author's data suggest that the observed geomagnetic reversals were associated with palaeoclimatic variations in a cause-and-effect relationship.

Where such variations are expressed in the stratigraphic column as changes in the size of clastics, the author suggests that palaeoclimatic change as related to the onset of the deposition of the massive conglomerates might have been represented by a period of high precipitation, the date of which is shortly after 2.47 Myr ago since the lower boundary of the conglomerates is slightly above the Matuyama-Gauss Boundary. Therefore, it may be said that the U.B.F. distal conglomerates mark a depositional regime of vigorous fluvial activity denoting a high rainfall period spanning enough time to constitute a pluvial phase commencing shortly after 2.47 Myr ago.

Other Regional Evidence: A possible interrelated palaeoclimatic event that may attest to the proposed pluvial phase may come from the palaeoenvironmental depositional regime of the Dibdiba Formation of southern Iraq, north-northwest Kuwait and northeast Saudi Arabia. The Dibdiba Formation is composed of red conglomerates, gravelly quartzitic sandstones and sandstones and is considered to be the southern facies equivalent (at least partially) to the U.B.F. Its source is believed to be the crystalline basement of the Arabian Shield and it attains a maximum thickness near the town of Basra in south Iraq and then extends westward (Al-Naqib 1967). The present drainage system, which dissects the Dibdiba Plain, is represented by *wadis* draining the northern parts of the Arabian Peninsula and descends towards the Mesopotamian Plain basin (Fig. 2). The presence of such an extensive gravelly formation indicates a period of high rainfall (Holm 1960), and we are inclined to regard the present major *wadi* system as a relict of the vigorous water courses that have existed at a time coeval with our proposed pluvial phase. It is evident that the tectonic factor had nothing to do with the formation of the Dibdiba Formation (as was the case with the U.B.F.), and only climatic change played a decisive role.

Conclusion

From the foregoing discussion it may be concluded that regional climatic deterioration connected with global climatic variations and external forcing (see the palaeomagnetic-climatic connection) had been amplified by internal feedback interactions through the uplift of the Zagros mountains. This occurred during the paroxysmal phase of the Alpine Orogeny which provided an orographic effect when the westerly Mediterranean "heavy" moisture-laden winds were checked by the raised topographic barriers (e.g. the Zagros Range). This resulted in high precipitation rates on the windward slopes in contrast to the aridity east of the leeward side of the Central Iranian Plateau. Moreover, it is evident that the proposition of a pluvial phase occurring shortly after 2.47 Myr ago (i.e. the base of the U.B.F. conglomerates) points to a significant climatic event synchronous with the palaeoclimatic threshold indicated by the start of the first cooling in northwest Europe. This is marked by:

> the base of the Pretiglian Stage (Zagwijn 1957),
>
> the initiation of major Northern Hemisphere Glaciation (Shackleton *et al.* 1984),
>
> commencement of loess deposition in Europe (Kukla 1975; Fink and Kukla 1977),
>
> start of loess deposition in China (Heller and Tungsheng 1982 and 1984; see Fig. 4), significant faunal changes in both Antarctic cores (Hayes and Opdyke 1967) and in the north China sequences (Anzhisheng 1984),
>
> a general drop in sea level (Stipp *et al.* 1967),
>
> as also the cooling of Mediterranean basin (Suc and Zagwijn 1982) and of Greece (Paepe *et al.* 1984).

The opinions expressed by Sastry *et al.* (1982), Shackleton *et al.* (1984) and Aguirre and Passini (1985) regarding their disagreement on the adoption of climatic deterioration as the main criterion for defining the Pliocene-Pleistocene boundary on the ground that it has a diachronous character, may therefore, be due for reconsideration. Furthermore, although the officially approved Pliocene-Pleistocene boundary is now defined at 1.64 Myr (Aguirre and Passini 1985) the data show that the level just above 2.47 Myr, as defined lithostratigraphically in the area, may prove to have much practical impetus in the choice of the Pliocene-Pleistocene boundary in the continental sequences of the Middle East.

Acknowledgment

The author is grateful to H.W. Zagwijn of Rijks Geologische Dienst of the Netherlands who kindly read the original manuscript.

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Sequence Stratigraphy of the Surface Quaternary Deposits in the Semi-Arid Basins of Gujarat

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Abstract

The Quaternary geology of the semi-arid regions of Gujarat is to be found within three major river basins, namely, the Lower Narmada, the Mahi and the Sabarmati. The Lower Narmada Quaternary deposits are divisible into three formations, the Tilakwada, Ambali and Broach Formations. Likewise, the Mahi and Sabarmati Quaternaries are also divisible into the Raika, Shihora and Timba Formations (Mahi), and the Hirpura, Vijapur and Valasna Formations (Sabarmati). Midway through the Quaternary succession there is a conspicuous red soil (rubified) horizon which has been considered as a marker horizon for stratigraphical correlations between and among the three basins. The composite succession appears to date back to the Middle Pleistocene.

Introduction

The Quaternary deposits of the central Gujarat semi-arid plains are very promising and unique in the sense that they represent a sequence of geological records preserving evidences of climate change, tectonic activity and glacio-eustasy. Although, these Quaternary deposits have received some attention in the past, a precise sequence stratigraphy, their true nature and the environmental conditions that prevailed during their formation, are yet to be investigated.

The Quaternary deposits exposed in the semi-arid central Gujarat plains have attracted the attention of geologists, palaeontologists and archaeologists from the 19th century onwards. Studies by Foote (1898), of the alluvial and sub-aerial formations have provided the foundation for all those who have worked on the Quaternary geology of the central Gujarat plains. Sankalia (1946) worked on the prehistory of Gujarat and his contributions to the geology and archaeology of Gujarat are noteworthy. Zeuner (1950) who studied the three major rivers of Gujarat, the Sabarmati, Mahi and Narmada put the prehistoric findings of Sankalia in their proper stratigraphical context. He concentrated on the alluvial and aeolian stratigraphy and according to him, the Sabarmati represented the most complete sequence of the three rivers (Table 1). Zeuner (1963) also interpreted the buried soils in climatic terms.

Wainwright (1964) described the Pleistocene deposits of the Lower Narmada river, but his stratigraphy lacks details and a regional perspective. According to Allchin *et al.* (1978), the state of Gujarat falls into two distinct provinces; mainland Gujarat and the Kathiawar Peninsula. According to them, mainland Gujarat comprises the fertile coastal plain built by Pleistocene and Holocene alluvial deposits and the Kathiawar Peninsula in many respects is like a vast outlier of the northern Deccan, mountainous and with a radial system of drainage. Subbarao (1952) and Allchin *et al.* (1978) more or less followed the stratigraphy provided by Zeuner (1950). Pant and Chamyal (1990) were able to provide a detailed stratigraphy of the Quaternary deposits of the Mahi river basin in Gujarat.

Overall, no detailed chronological studies using radiocarbon and TL techniques are available. Realising this, and the importance of Quaternary stratigraphy in interpreting the Quaternary successions — depositional, erosional, climatic and soil-forming events — the authors surveyed the three major river basins of Gujarat, the Sabarmati, the Mahi and the Narmada, in an attempt to provide a tentative stratigraphical sequence for the central Gujarat semi-arid plains. For this purpose they considered the vertical stratigraphic sequences encountered in the various river sections. This paper gives a detailed account of the Quaternary sediments occurring in the Narmada, Mahi and Sabarmati basins.

Table 1: Sequence of alluvial deposits and associated cultural remains on the Sabarmati River, North Gujarat (Zeuner 1950)

	Geomorphic Feature	Climatic Interpretations	Culture
Z	Modern surface	Sufficient precipitation to maintain soil under natural conditions	Modern
Y	—	?Dry phase, or increased human activity destroying natural vegetation	Iron Age and Chalcolithic
X	Soil on dune surface	Wetter than previous phase	Microliths
W	Dune formation	Drier	?
V	Flat surface developed on soil in Sabarmati area	Damper	?
U	River aggrading alluvial silt and aeolian sand	Major dry phase	?
T	Red soil formed on Sals	Climate humid but not so much so as P	Lower Palaeolithic artefacts
S	Silts and Sands	Climate drier	Lower Palaeolithic artefacts
R	Cemented gravel	Precipitation heavier than today, floods	Lower Palaeolithic artefacts
Q	Mottled clay deposited in basin	Climate drier than previously	Lower Palaeolithic artefacts
P	Allitic weathering, formation of laterite crusts, hilly land surface	Humid climate	?

Narmada River Basin

The main sites studied in the Lower Narmada basin are the Men river section (tributary of the Narmada) at Jetpur, Tilakwada, the Orsang section at the mouth (Chandod), as well as Maletha, Kanjetha, Ambali, Ranapur, Nareshwar, Nikora and Broach. Figure 1 shows the distribution of measured profiles, while Fig. 4A presents the composite lithostratigraphic profile. The exposed Lower Narmada Quaternaries are divisible into three formations, i.e. the Tilakwada, the Ambali and the Broach Formations. The detailed lithological characteristics and regional correlation of these formations are presented in Table 2 and Fig. 4.

Tilakwada Formation

Amongst the exposed Quaternaries in the Lower Narmada basin, this formation is considered to be stratigraphically the oldest. The formation is broadly divisible into three members: a basal clay and two gravels. The basal part of this formation is characterised by a clay deposit, which is bluish grey to light brown in colour. Overlying the clays there is a thick conglomeratic deposit: gravel-I. The gravel has a carbonate matrix and is exposed extensively all along the Narmada river though it abuts against a mud deposit downstream of Kanjetha. At places it is a compact and highly cemented conglomerate and consists of pebbles, boulders, cobbles and fragments of quartzites, volcanics and sandstone. The lower part of the horizon, in some localities (such as at Ambali), shows distinct cross-bedding. At certain localities (Tilakwada) the horizon has many sand lenses (Fig. 1). The other prominent member of the Tilakwada Formation, gravel-II, is separated from gravel-I by either a clay horizon, which is laminated and mud-like (characterised by hydromorphic features, burrowings and clay coatings), or by a reddish sand. Gravel-II is also supported by a carbonate matrix which is cross-stratified at places. Pseudolaminated clay lenses are noticed within this horizon.

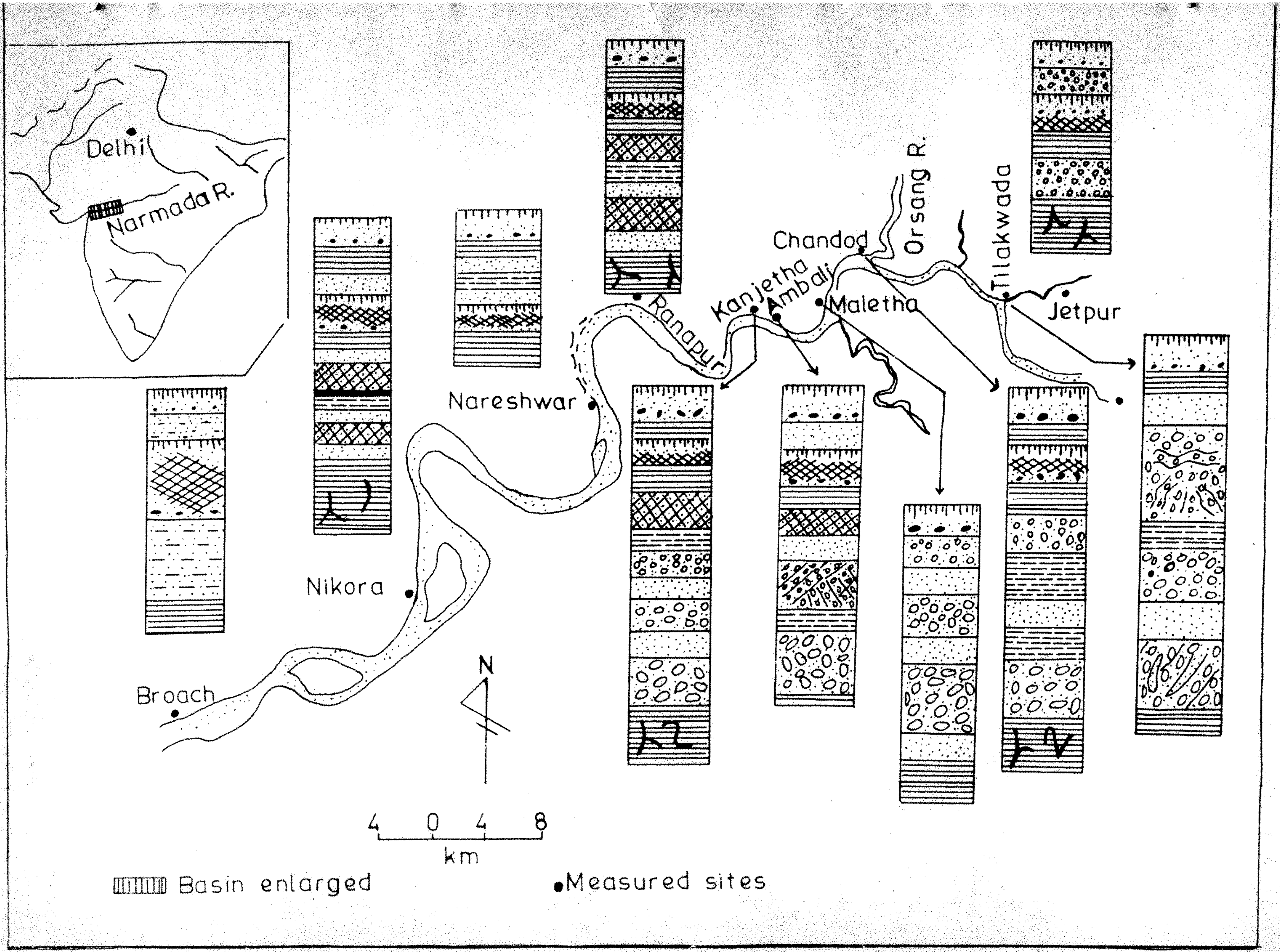

Fig. 1: Distribution of measured Quaternary sediment profiles along the River Narmada
(Lithological symbols similar to those in Fig. 4)

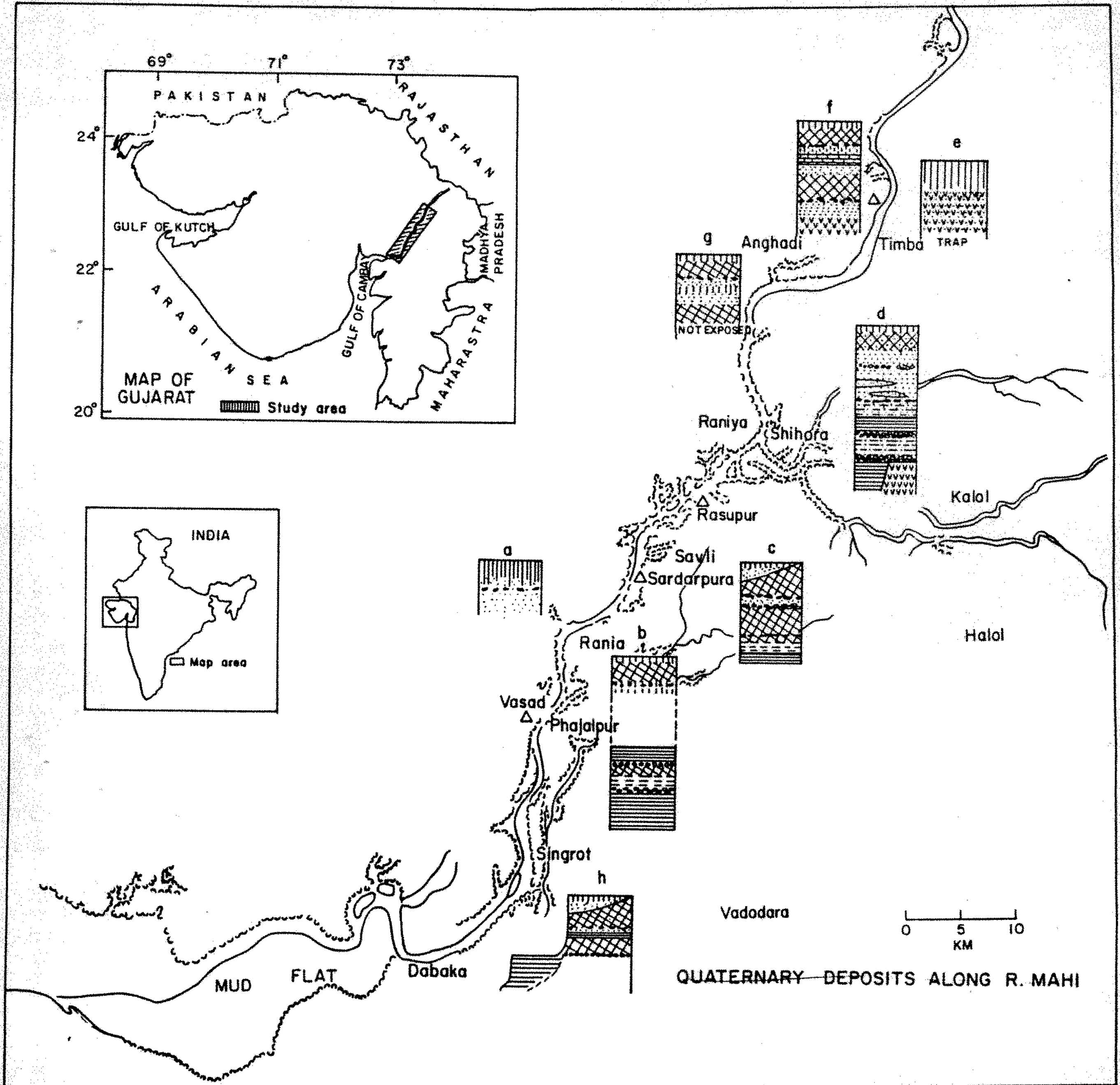

Fig. 2: Distribution of measured Quaternary sediment profiles along the River Mahi (after Pant and Chamyal 1990) (Lithological symbols similar to those in Fig. 4)

Ambali Formation

This formation, which overlies the Tilakwada Formation, consists of three members: laminated mud or sand, gravel-III and a rubified soil horizon, which is well exposed at Ambali, hence the name. The lowermost member of this formation is a reddish sand. However, at places it is replaced by laminated mud. The sand is mainly fine to medium grained and forms a layer which is about 1.5 m thick. The horizon is devoid of any fossils, but it does contain a few gastropod shells. The laminated mud is generally found overlying the Tilakwada Formation in the lower reaches of the river. It shows internally graded laminae, often limey and marly containing freshwater molluscs. To some extent, this unit has undergone pedogenesis and is overlain by a thin gravel bed (gravel-III). In the upper reaches of the Lower Narmada, gravel-III is replaced by a thick deposit of sand. These sands are also cross-stratified. This formation is capped by a rubified soil horizon and is mappable downstream from Ambali. It is most conspicuous by it colour and spatial spread. This soil has perhaps developed on fine sandy silt and is characterised by a well developed carbonate crust at the base.

Broach Formation

Immediately overlying the Ambali Formation is a relatively thin horizon of laminated mud. This horizon is overlain by a greyish yellow laminated silty sand bed which is quite thick and is extensively exposed along the lower reaches of the Lower Narmada basin. Several stratified, and at places fine-grained unconsolidated sand layers, are seen replacing the yellowish, silty sand bed. The silt is coarse-grained and contains a small amount of sand. Best exposed at Broach and hence the name, this formation is predominantly aeolian. The top of the composite succession of the Quaternary deposits is marked by vertisol commonly known as black cotton soil.

The Quaternary sediment succession in the Narmada basin is intercalated by various palaeosol horizons. However, the two reddish brown ones noticed at Nikora fulfill their definition as far as field criteria such as colour, texture, structure and grain size, are concerned. Among the surface soils as pointed out by Wainwright (1964), the black cotton

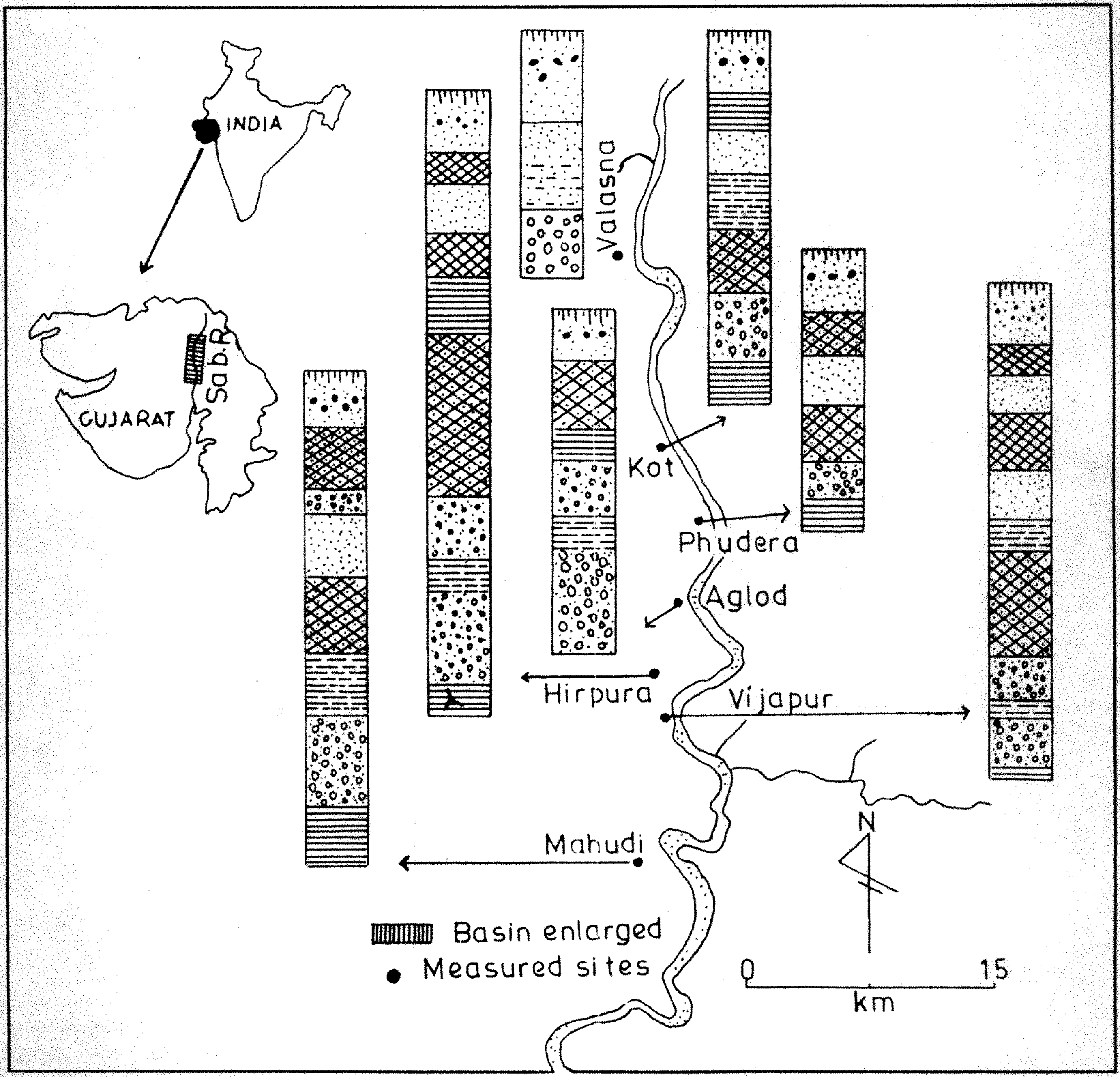

Fig. 3: Distribution of measured Quaternary sediment profiles along the River Sabarmati (Lithological symbols similar to those in Fig. 4)

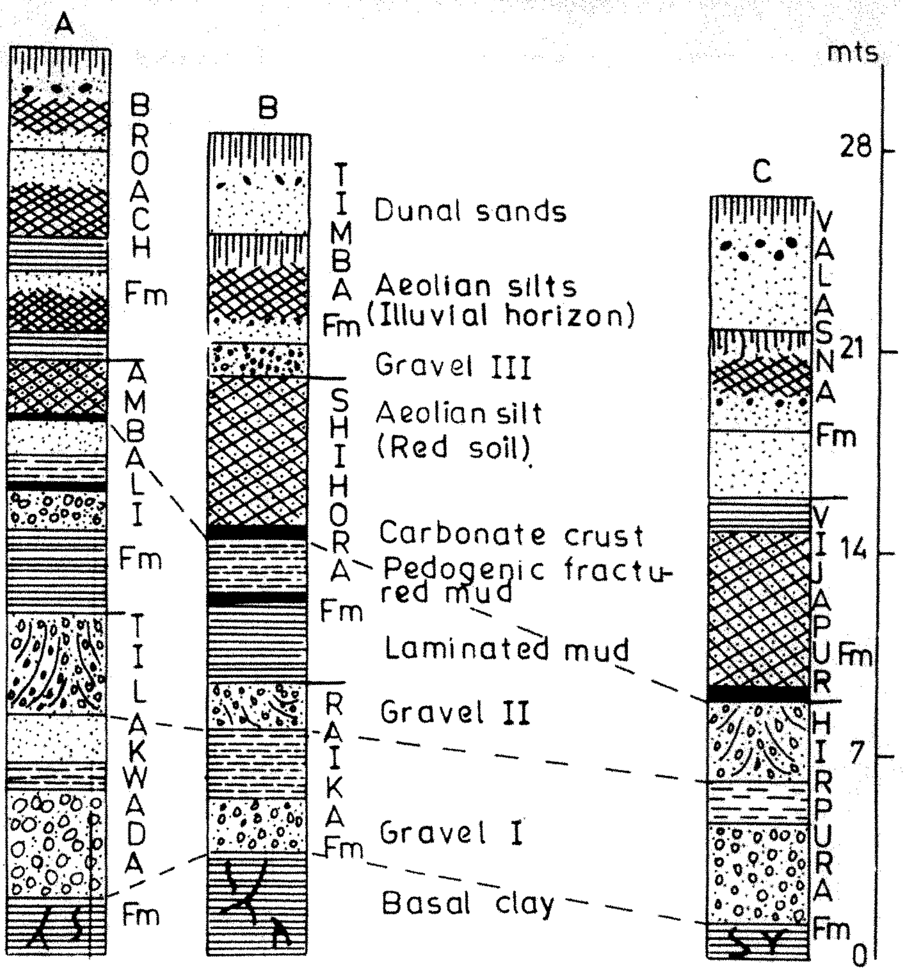

Fig. 4: Composite Quaternary sediment profiles of river basins: (A) Narmada, (B) Mahi, (C) Sabarmati

soil is the most widespread and forms a deeply weathered horizon measuring 1 m to 3 m. It is completely devoid of calcium carbonate. The surface of the soil shows polygonal cracks, a typical characteristic of vertisols. The other surface soil noticed on isolated hillocks is a brown chestnut type of soil (Wainwright 1964) which is rich in CaCo3. The brown soil developed on silty sand shows deep weathering with a well developed A-B-C profile.

Mahi River Basin

Pant and Chamyal (1990) have been able to provide a composite stratigraphy (Fig. 2 and 4B) of the Mahi Quaternary deposits. According to them the total thickness of the exposed Quaternaries in this basin is about 30 m. Table 2 shows the details of the Mahi Quaternaries and their correlation with the Lower Narmada and Sabarmati deposits. The succession of Quaternary deposits in the Mahi river basin are similar to those of the Lower Narmada Quaternaries and they are also divisible into three Formations: the Raika, the Shihora and the Timba.

Raika Formation

The basal part of this formation is a clay deposit whose lateral extension is nearly 30 km (Pant and Chamyal 1990). According to Murthy (1975) the clay deposit, a few hundreds of metres downstream of Raika village, reaches a depth of 25 m below the datum line, which apparently refers to msl, without touching the basement. Hence, to reconstruct the stratigraphy of the Quaternary deposits, the structural configuration of the Mahi river basin was delineated by Pant and Chamyal (1990). Gravel-I, which directly rests on the basal clays, has been reported to be implementiferous. Subbarao (1952), recorded Lower Palaeolithic tools consisting of an "Abbevilleo-Acheulean industry, mixed with a few pebble choppers and flakes" from this gravel. Overlying the gravel-I, is a structureless highly fractured mud which is characterised by hydromorphic features, burrowings and clay coatings along the cracks indicating that it has undergone pedogenesis. This fractured mud horizon separated the two gravels. The gravel-II which is the youngest member of the Raika Formation includes clasts of pebble to cobble size carbonate nodules. Cross-stratification is well preserved and

Table 2: Lithostratigraphy of the exposed Quaternary deposits in the semi-arid basins of Gujarat

	Narmada river basin		**Mahi river basin**		**Sabarmati river basin**	**Age**
Formation	**Lithology**	**Formation**	**Lithology**	**Formation**	**Lithology**	
Broach	Vertisol, yellowish silty sand, cross-fine grained sand, laminated mud at the base	Timba	Dunal sands, aridisol, aeolian silt, brown soil, coarse sand and gravel-III	Valasna	Aridisol, dunal sands, aeolian silt, yellowish sand	Recent to Terminal Pleistocene
Ambali	Silty sand, red (rubified) soil, coarse reddish sand, gravel-III, pedogenised laminated mud	Shihora	Aeolian silt, red (rubified) soil, highly fractured and pedogenic mud, finely laminated mud with marly bands	Vijapur	Pedogenised laminated mud, thick red (rubified) soil developed over silty sands	Late Pleistocene (Wisconsin)
Tilakwada	Cross-stratified gravel-II, coarse reddish sand or pedogenised laminated mud, gravel-I, reddish brown mottled clay/bluish basal clay	Raika	Cross-bedded gravel-II, carbonate rich and pedogenically altered fractured mud gravel-I, clay laminations alternating with marly bands, mottled at places	Hirpura	Cross-stratified gravel-II, pedogenised fractured mud, consolidated gravel-I, greyish, bluish, greenish basal clay, mottled at places	Late Middle Pleistocene to Middle Pleistocene

at places high plunging forests dip in a SW direction.

Shihora Formation

This formation, consisting of fluvial and aeolian sediments, is well exposed around Shihora, hence the name. The lowermost member is a horizontally laminated mud deposit (Fig. 2 and 4B) which contains fresh water molluscs and is overlain by a fractured pedogenised mud. This is probably a truncated soil of which only the lower part remains (a residual soil). The topmost member of this formation is a fine sandy silt of aeolian origin over which a red soil (rubified) has developed. The red soil is most conspicuous by its colour and spatial spread and is considered by Pant and Chamyal (1990) as a marker horizon for stratigraphical correlations for the entire Gujarat region.

Timba Formation

The lowermost deposit of this formation is a matrix supported gravel-III (confined to a small area Raika village) or a thick sand deposit. These sands are cross-stratified and are overlain by a quite thick silt deposit. This silt is relatively coarse grained and contains a considerable amount of fine sand. A deep weathered soil profile (brown soil) has developed over the loess-like material. Low dunes characterise the present-day topography. All these dunes are stabilised, as is evident from the soil formation over them. The soil developed over the dunes is a typical aridisol.

Sabarmati River Basin

The Sabarmati alluvial plains are the northerly extension of the central Gujarat alluvial plains, comprising both fluvial as well as aeolian deposits. The total exposed sediment thickness in the cliff sections recorded is over 30 m and is divisible into three formations; the Hirpura, Vijapur and Valasna Formations. Figure 3 shows the distribution of measured profiles whereas Fig. 4C is a composite profile of the total sediment succession. The detailed lithostratigraphy is presented in Table 2.

Hirpura Formation

This formation is characterised by a basal clay deposit which is greyish, bluish or greenish in colour, and probably marks the oldest exposed Quaternary deposit. At places the clay is seen resting on the basement rocks and appears to be a deposit laid down in ponded conditions. This clay deposit is overlain by a thick conglomeratic deposit (gravel-I) which is reported to be implementiferous (Sankalia 1945). In the upper parts of this formation a pedogenised mud separates the gravel-II from the underlying gravel-I. The gravel-II is cross-stratified and loosely cemented whereas it is well cemented near the Vijapur-Himatnagar bridge and separated from the older gravel by yet another horizon of mottled clay.

Vijapur Formation

The Vijapur Formation which overlies the Hirpura Formation is composed of a lower thick red soil (rubified) and an upper laminated mud horizon which has undergone considerable pedogenesis. The red soil horizon is very conspicuous by its colour and extends along the river for many kilometres. The depth of reddening near the Vijapur-Himatnagar bridge is about 7 m.

Valasna Formation

The Valasna Formation is the youngest and mainly consists of aeolian sediments. A yellowish sand deposit occurs over the Vijapur Formation which, in turn, is overlain by a structureless, porous, homogeneous and calcareous silty deposit (loess). The silt is mainly coarse in size and capped by a brown soil in its upper parts. Low hummocky dunes over which a aridisol has developed form the present-day topography.

Discussion

The Gujarat semi-arid basins (Narmada, Mahi, Sabarmati) provide a composite Quaternary stratigraphy. It appears that Quaternary sedimentation in the area followed the basement fracture pattern which is perhaps a reflection of the Cambay Basin tectonism.

The total average sediment thickness (exposed) in all the three basins is calculated to be about 35 m on the basis of the maximum extent of the individual members along the rivers. The basal part of the vertical succession in all the basins is a bluish grey clay deposit which at places, overlies the basement rocks. Perhaps this forms the exposed Quaternary deposit and may be marine in origin in the lower reaches of all the rivers. The compact and cemented conglomerate-like gravelly horizon (gravel-I) is reported to be implementiferous and has yielded Lower Palaeolithic tools (Subbarao 1952; Sankalia 1946). According to Pant and Chamyal (1990), the Lower Palaeolithic culture in Gujarat must have flourished before 200 kyr B.P. Therefore, they have suggested that the gravel-I and the underlying mud (clay) deposit may be older than 200 kyr.

The red soil (common in all the three river basins of Gujarat) has been appropriately considered by Pant and Chamyal (1990) as a marker horizon throughout Gujarat for reconstructing Quaternary stratigraphy. The red soil phase probably represents a more humid climate and is correlated with stage 5e of the deep sea oxygen isotope record, datable to around 125 kyr (Pant and Chamyal 1990). The red soil is overlain predominantly by sediments of aeolian origin. The soil formation over the aeolian deposits represents the arid phases that were followed by moist conditions. Evidence of at least two arid phases after the initial fluvial activity have been noticed in the Sabarmati basin. Although the soils mapped in the three semi-arid basins of Gujarat are well correlatable, there is some doubt regarding the presence of the vertic group of soils in the Sabarmati basin. The detailed lithostratigraphy of the Quaternary surface deposits occurring in different semi-arid basins of central Gujarat is presented in Table 2. The exposed sediment succession dates back to the Middle Pleistocene (Pant and Chamyal 1990).

Acknowledgements

The authors are grateful to Dr. R.K. Pant (P.R.L., Ahmedabad) and Dr. P.P. Patel, Department of Geology, M.S. University of Baroda for fruitful discussions in the field. L.S. Chamyal gratefully acknowledges financial support from the Department of Science and Technology, New Delhi.

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Phosphorus Analysis of Soils from Archaeological Sites in the Mid-Central Himalaya and Ganga-Yamuna Doab

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Abstract

This paper reports the results of phosphorus estimation of soils from archaeological sites in the Garhwal Himalaya and the Ganga-Yamuna Doab. The analyses have been undertaken to ascertain the concentration of different fractions of phosphorus in anthropogenic sediments. The data has been examined statistically to establish the correlation between different fractions of phosphorus. The study confirms that the total phosphorus was enriched by the level of organic phosphorus at the PGW site of Purola. The results from explored sites also confirm the potential of phosphorus analysis in locating archaeological sites.

Introduction

The phosphorus analysis of soils from archaeological sites has been carried out in recent years to draw inferences regarding the various aspects of cultural occupation, especially of burial sites (Proven 1971, 1973; Eidt 1977; Proudfoot 1976; Bakkevig 1983; Conway 1983). These soils are referred to as anthropogenic soils and, since the initial use of phosphate analysis by Arrehenius in 1931 as a field test to locate archaeological sites, the technique has been modified and widely applied in various ways (Eidt 1977). For example, Lorch (1940) has shown that the differing effect on the soil of the faeces and manure of domesticated animals makes it possible to distinguish different patterns of land use in prehistory, Other important studies are those of Lutz (1951), and Cook and Heizer (1965) on the probable level of phosphorus accumulation in archaeological sites; of Proven (1973) and Griffith (1980) who examined the soils associated with sites; and of Keeley *et al.* (1977) who examined burial deposits to study the relationship between manganese and phosphorus.

Recently, Conway (1983) investigated the phosphorus content of soil from occupational levels of a Romano-British Hut group from North Wales in order to differentiate the various activity areas at this habitational site. Bakkevig (1980) critically reviewed the value of phosphate analysis. A few studies have also been done on the Chalcolithic sites of Maharashtra, in India. Joshi *et al.* (1978 and 1986), on the basis of the estimation of phosphate concentration, have studied the intensity of human occupation during the various cultural phases at the Chalcolithic site of Diamabad. Deotare *et al.* (1988) detected high phosphorus and organic carbon in an Early Jorwe house at Inamgaon. Recently Deotare (1990), on the basis of variable concentrations of phosphorus and organic carbon in different layers, has estimated the intensity of occupation at the Chalcolithic site of Tuljapur Garhi in Maharashtra. Similarly a Harappan site at Nagwada in Gujarat has been excavated on the basis of phosphate concentration (Hegde *et al.* 1986). Interestingly, the phosphorus concentration of burials was found to be quite low as compared with the habitational levels from the burial complex of the Megalithic site of Naikund, near Nagpur, in Maharashtra (Joshi and Deotare 1982).

Phosphate prospecting is based on the principle that the phosphorus level in the soil gets enriched due to the gradual accumulation of organic residue (urine, excreta, plant debris and food refuse) (Proudfoot 1975; Conway 1983). Some authors consider urine alone as a source of phosphate (Cook and Heizer 1965; Mauritzen 1969; Proven 1971). The phosphorus thus produced forms insoluble compounds mainly with iron, aluminium and calcium (Bakkevig 1980). Such compounds being stable can be detected in the soil even after thousands of years (Bakkevig 1980; Shackley 1981). Nevertheless, several factors affect the concentration of phosphorus in the soil. The major factors identified, include the natural content of phosphorus in the parent material, the edaphic and climatic factors as well as the effect of leaching due to the mobility of phosphorus in the soil (Bakkevig 1980). Black (1968) also found that phos-

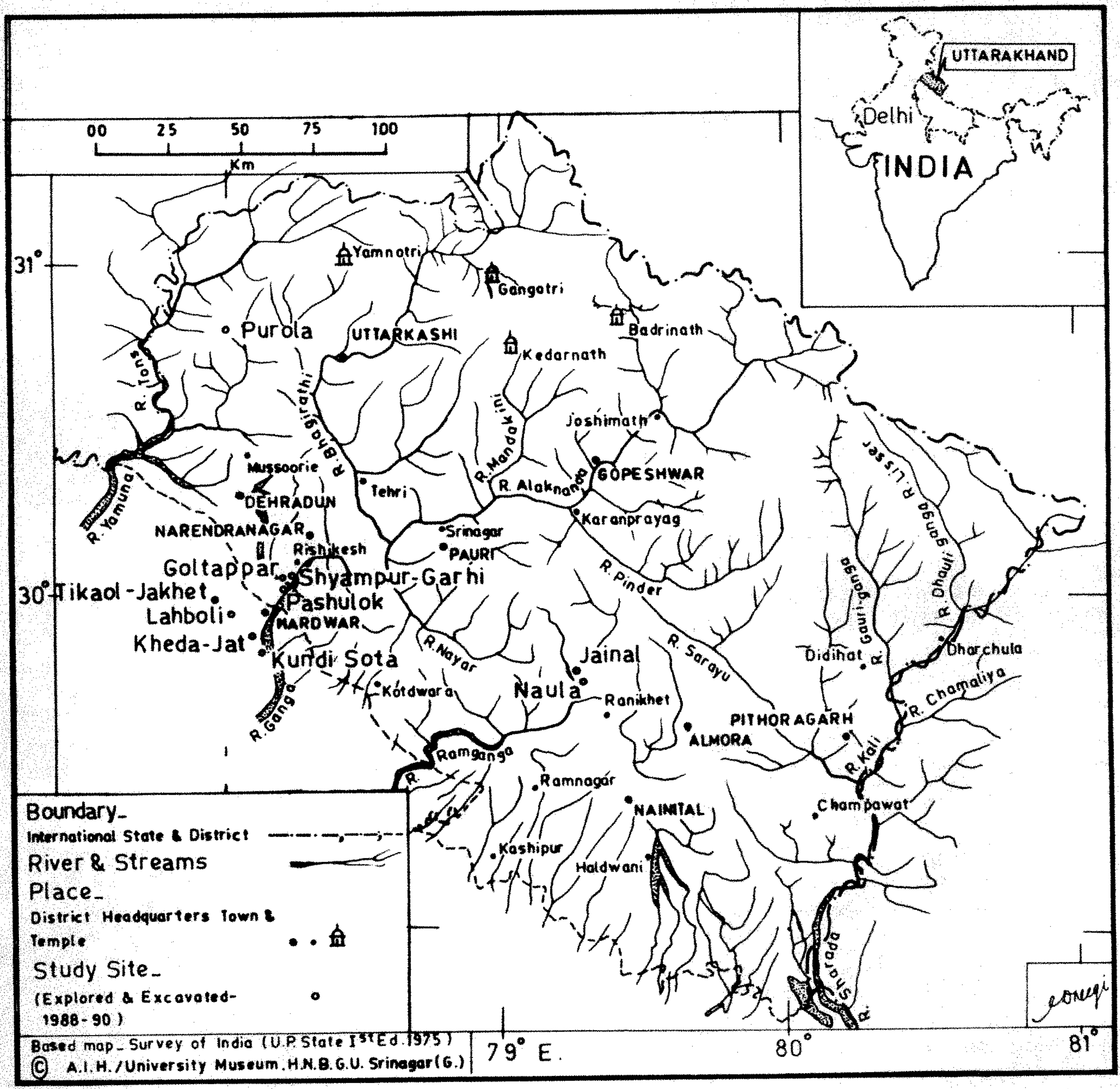

Fig. 1: Explored and excavated sites in Uttarakhand and the Ganga-Yamuna Doab

phate concentration is controlled by many variables, e.g. the phosphate content of soil, which itself is dependent on soil type, growth conditions and on plant and animal species. However, in spite of these limitations, a few researchers have worked out the total value of phosphorus generated by human settlements. Cook and Heizer (1965) arrived at a figure of 62 kg^{-1} for a group of 100 people, and a general level of phosphorus, within the confines of the settlement, of 1-10% per annum. Tauber (1969) estimated a value of 500 to 700 gm of phosphorus in the adult body of a man, while Heraldson (1979) estimated a figure of 1592 gm of phosphorus in an adult weighing 75 kg. These studies have also shown that nearly 1% of the weight of the human body is phosphate and the practice of inhumation enriches the phosphate content of the soil (Shackley 1981). Therefore, the phosphorus is concentrated in a very small area at a burial site resulting in a localised very high phosphorus value.

Based on these findings, the detection of burials through phosphorus analysis has also been attempted. Solecki (1951) had shown that it is possible to identify graves on the basis of a high level of phosphorus. Recently, at the Finish Mesolithic site of Kilteri which has been dated to c. 5000 BC, graves have been detected in the acidic soil which rarely preserves bones (Nunez 1975).

Table 1: Percentage of available phosphorus in the stratified deposit of the PGW site at Purola

Profile No	Soil sample	Percent phosphorus (a)	Soil sample	Percent phosphorus (b)	Soil sample	Percent phosphorus (c)	Mean of P (%) a,b,c
1	Humus	0.064	Humus	0.064	Humus	0.064	0.064
2	I	0.049	E	0.066	C	0.064	0.063
3	B	0.027	X	0.026	V	0.028	0.027
4	U	0.052	O	0.031	0	0.017	0.033
5	N	0.032	J	0.064	H	0.034	0.043
6	G	0.102	C	0.094	A	0.042	0.079
7	Natural	0.025	Natural	0.025	Natural	0.025	0.025

In this paper, we present the results of the phosphorus analysis of soil samples from a single phase Painted Grey Ware (PGW) site at Purola, Uttarkashi District, Uttar Pradesh, excavated in 1987-88 (Nautiyal *et al.* 1989). Similar analysis was carried out on soil samples from a burial site at Jainal in the Ramganga valley, District Almora, as well as from an Ochre Coloured Pottery (OCP) site and a Late Harappan site in the districts of Hardwar and Saharanpur respectively (Fig. 1).

In addition to the estimation of total phosphorus, the concentration of available or extractable phosphorus also has been determined following the work of Conway (1983). Furthermore, the values of phosphorus have been examined statistically in order to establish the correlation coefficient between the different fractions of phosphorus.

Material and Method

Since the aim of this analysis was to study the spatial distribution of phosphorus at Purola, the 1.10 m thick deposit was divided into 7 profiles (Fig. 2) and a total of 21 samples were collected (three from each profile). A set of 5 samples was collected from each of the other explored sites. The soil samples were ground mechanically, sieved through a 2 mm mesh and analysed according to Hesse (1971) and Trivedi and Goel (1980). Simultaneously the transmittancy of the various dilutions of the standard KH_2PO_4 was determined as a blue phosphomolybdate complex in sulphuric acid at 690 mm. The values obtained in mg^{-1} were plotted graphically (3 log scale graph) and a standard curve was drawn.

In order to estimate the extractable or available value of phosphorus, the soil sample was treated with 0.002 NH_2SO_4, while for the total phosphorus, 0.5 gm of powdered soil sample was digested in nitric and perchloric acid (1:1). The method for determining the transmittancy of each sample was similar to that employed for the standard solution and the concentration of both the fractions was estimated from the standard curve. The organic fraction of phosphorus is calculated by subtracting the value of avail-

Table 2: Estimates of the total phosphorus concentration in soil samples from the PGW site at Purola

Profile No.	Soil sample	Percent of phosphorus (A)	Soil sample	Percent of phosphorus (B)	Soil sample	Percent of phosphorus (C)	Mean of phosphorus A,B,C
1	Humus	0.068	Humus	0.068	Humus	0.068	0.068
2	I'	0.138	E	0.138	C'	0.111	0.119
3	B'	0.078	X	0.068	V	0.126	0.084
4	U	0.160	O	0.100	O	0.80	0.113
5	N	0.111	J	0.148	H	0.085	0.115
6	G	0.105	C	0.205	A	0.123	0.144
7	Natural	0.051	Natural	0.051	Natural	0.051	0.051

Table 3: Correlation between total phosphorus and available phosphorus at Purola

Sample profile	Mean value of total phosphorus % (X)	Mean value of available phosphorus % (Y)	XY	X^2	Y^2	B	a	Correlation coefficient
1	.068	.064	.0044	.0046	.004096			
2	.119	.060	.0071	.0142	.0036			
3	.084	.027	.0023	.0071	.000729			
4	.113	.033	.0037	.0127	.0001089	1.3783	.6255	.023
5	.115	.043	.0149	.0132	.001849			
6	.114	.079	.0114	.0207	.00624			
7	.051	.025	.0013	.0026	.000625			
n=7	EX=.694	EY=.331	EXY=.0351	EY^2=.0751	EY^2=.18229			

able phosphorus from the value of total phosphorus (Trivedi and Goel 1980), as the soil contains both the organic and inorganic fractions (Black 1968). The present data on the different fractions of phosphorus have been examined statistically and a correlation coefficient (r) has been established to find out the relationship between the different fractions of phosphorus following the method of Shennan (1988), where:

a = total phosphorus and available phosphorus
b = total phosphorus and organic phosphorus
c = available phosphorus and organic phosphorus.

The values of a, b, c (F I) and r (F II) are calculated by the following formulae

$$a = \frac{EY - bEX}{n} \quad \text{......... F I}$$

$$b = \frac{nEXY - (EX)\,(EY)}{nEX^2 - E(X)^2} \quad \text{......... F I}$$

Here a and b are the regression coefficients and the other values are estimated in Tables 4, 5 and 6 and from these values the correlation r is calculated:

$$r = \frac{nEY - (EX)\,(EX)}{\sqrt{[\{nEX^2 - (EX)^2\}\,\{nEY^2 - (EY)^2\}]}} \quad \text{......... F II}$$

Results

The experimental results described in Tables 1 and 2 show that the concentration of available and total phosphorus is uniform in a horizontal plane moving from left to right in both the humus (profile-1) and in the natural soil (profile-7). However, moving from left to right in layer 2 and 3 (profile 4 and 6), there is a gradual decrease in the concentration of the available fraction of phosphorus. In all the other profiles, no significant variation is noticed except for a slight fluctua-

Table 4: Correlation between total phosphorus and organic (anthropogenic) phosphorus at Purola

Soil profile	Mean value of total phosphorus % (X)	Mean value of organic phosphorus % (Y)	XY	X^2	Y^2	B	a	Correlation coefficient
1	.068	.004	.003	.0046	.000016			
2	.119	.069	.0082	.0142	.004261			
3	.084	.064	.0054	.0071	.00409	0.67113	.01239	.778
4	.113	.080	.0090	.0127	.0064			
5	.115	.071	.0082	.0132	.00504			
6	.114	.065	.0094	.0207	.00423			
7	.051	.026	.0013	.0026	.000678			
n=7	EX=.694	EY= .379	EXY=.0418	EX^2=.0751	XY^2=.025209			

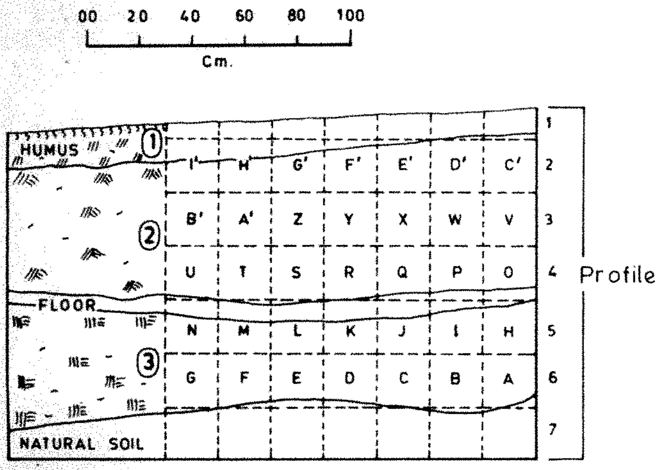

Fig. 2: Stratigraphy and sampling method of the PGW site at Purola (section facing south)

tion of the order of 0.02% in the upper portion of layer-3 (profile-5). The concentration of total phosphorus also shows a similar trend as noticed for the available phosphorus.

In the stratigraphic sequence (Figs. 2 and 3) from humus to natural soil (from profile 1 to 7), it is observed that the mean value of the available fraction of phosphorus increases perceptibly from 0.063% to 0.79%. However, the concentration of total phosphorus does not show any significant pattern. The graphic representation shows the highest percentage of both available and total phosphorus in layer-3 (profile-6). The concentration of organic (anthropogenic) phosphorus shows an increasing trend from 0.004% to 0.080%, from humus to the lower part of the layer-2 (from profile 1 to 4). However, it starts showing a decreasing trend in the value from 0.080% to 0.026% from layer 3 up to the natural soil (horizon from profile 5 to 7).

The values of the correlation coefficient (r), shown in Tables 3 and 5 (Figs. 4, 5) is low, i.e. 0.023 and 0.095, indicating a weak relationship between the total phosphorus and available phosphorus and also of available phosphorus and organic phosphorus, respectively. It is, therefore, clear from the scattergram of the data (Figs. 4 and 5) that the points (X and Y) are randomly dispersed along the regression line. However, the X and Y points are closely spaced in relation to the regression line (Fig. 6) showing a significant relationship between total phosphorus and organic phosphorus thus resulting in a higher value (r = 0.778) of the correlation coefficient (Table 4).

The experimental results in Table 6 and Fig. 7 show the concentration of organic (anthropogenic) phosphorus in the soil samples from the different explored sites. The results indicate that the value of phosphorus concentration in the soil samples of the OCP sites of Satikund and the Late Harappan sites of Lahaboli and Nashera, in the upper Ganga-Yamuna Doab, is approximately 0.0133% which is quite low as compared to the estimated phosphorus concentration (0.80%) in the floor level of the PGW site of Purola, as indicated earlier. Similarly, the values of phosphorus concentration in the soil samples of Jainal, a burial site, is very low (0.018%). However, in contrast to Jainal the the value of phosphorous concertration from the soil sample from Kalagarh, an early historic site, is slightly higher (0.029%), but quite low as compared to the PGW site of Purola.

Discussion

In light of the above, it may be said that the concentration of the fraction of phosphorus in all the layers is uniform in horizontal profile. However, a different trend is perceived in the stratified deposits of the site. The scattergram of the relationship between different fractions of phosphorus clearly shows that the level of total phosphorus is not enriched significantly by the level of available phosphorus. A similar pattern has been observed with regard to available phosphorus and organic phosphorus. However, the highest value of the correlation coefficient (r) between total phosphorus and organic phosphorus clearly shows a high concentration of the fraction of organic phosphorus. The values of organic phosphorus, which seemed to have been generated by human occupation, show an interesting trend in the stratified occupational deposits. Starting from the top (humus), the value of organic phosphorus shows an increasing trend up to profile-3 (layer-2). However, there is a sharp increase from the 3rd profile to the 4th profile (layer-2). This is followed by a declining trend which reaches a minimum value in the natural layer.

The sharp increase in the organic phosphorus in profile-4 seems to be due to intensive human activity. Incidentally, in this profile, a 20 cm thick floor level has been recorded. This clearly proves that the floor level was enriched with the additional phosphorus produced by human occupation. On the basis of these results, it can be said that human activity during the late phase was greater than during the early phase of the PGW settlement.

It is also found that the concentration of anthropogenic phosphorus shows a positive trend in all the sites. Regarding the results of our analysis of soil from the burial site of Jainal, it may be pointed out that these are in confirmity with the values reported for the burial complex at Naikund in Maharashtra (Joshi and Deotare 1982). Presently one of the burial complexes at Jainal is being excavated, and this will be subsequent sampled for detailed sedimentological analysis.

The low value of phosphorus estimated in the soil samples of the OCP and the late Harappan sites considered in this study suggests a relatively low level of human activity at all the surveyed sites. These results may be corroborated by the findings of previous field studies which

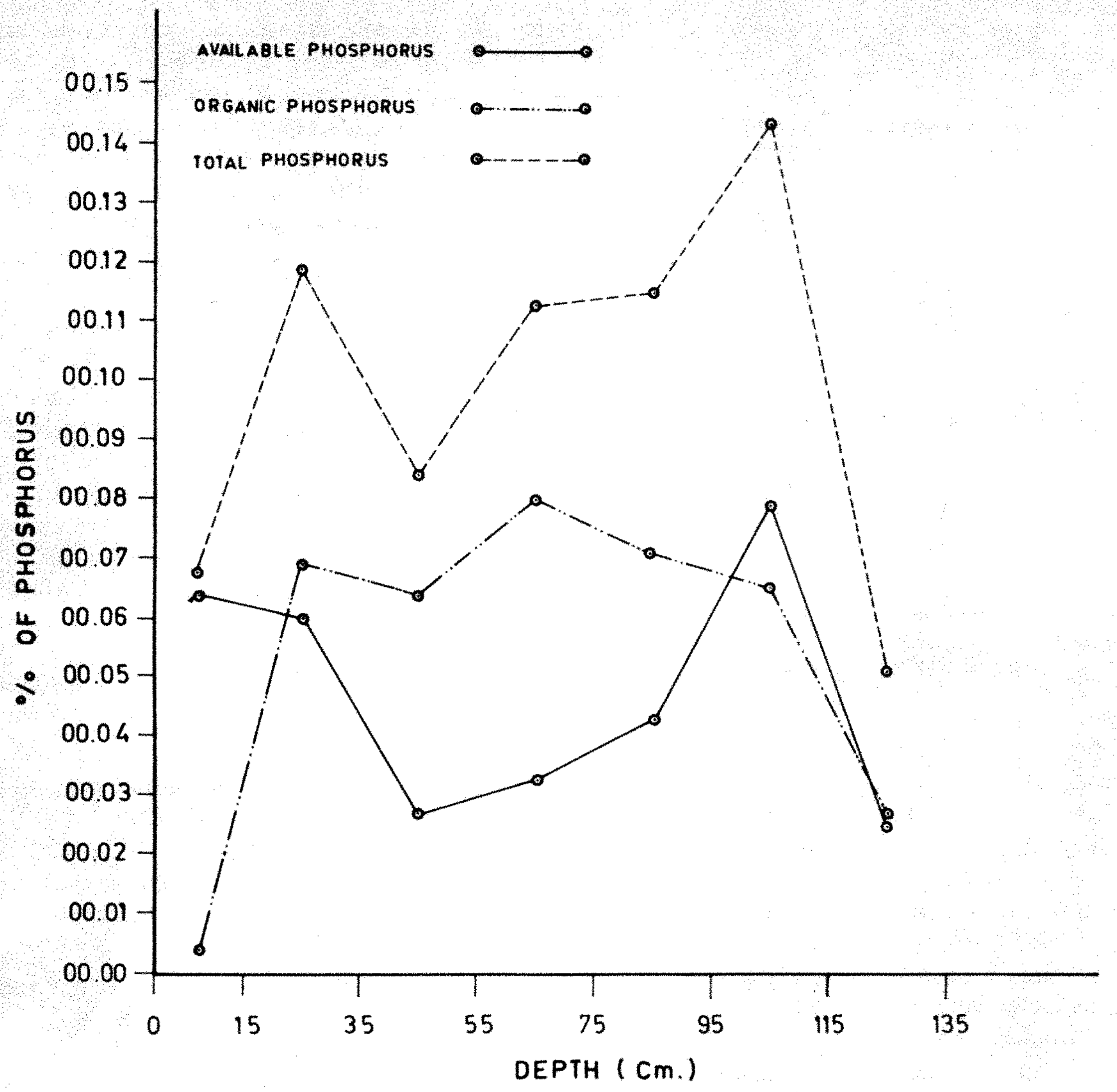

Fig. 3: Profile of available organic and total phosphorus in the stratified deposit of the PGW site at Purola

Table 5: Correlation between available phosphorus and organic (anthropogenic) phosphorus at Purola

Soil profile	Mean value of available phosphorus % (X)	Mean value of organic phosphorus % (Y)	XY	X^2	Y^2	b	a	Correlation coefficient
1	.064	.004	.003	.0041	.000016			
2	.060	.069	.0041	.0036	.064761			
3	.027	.064	.0017	.0007	.00409			
4	.033	.080	.0026	.0011	.0064	-.13126	.06035	-.095
5	.043	.071	.0031	.0018	.00504			
6	.079	.065	.0051	.0062	.004225			
7	.025	.026	.0007	.0006	.000676			
n=7	EX=.331	EY=.379	EXY=.0176	EX^2=.0181	EY^2=.025209			

Table 6: Mean percentage values of available, total and organic (anthropogenic) phosphates from the excavated site of Purola and other explored sites

Sr.No.	Archaeological site	Archaeological context	Concentration of available phosphorus (%)	Concentration of total phosphorus (%)	Concentratiuon of organic phosphorus (%)
1	Jainal	Burial site	0.0084 ± 0.0132	0.0267 ± 0.02101	0.0183 ± 0.0125
2	Kalagarh	Early Historic site	0.171 ± 0.0021	0.200 ± 0.1070	0.0293 ± 0.0132
3	Lababoli	Late Harappan site	0.233 ± 0.1020	0.266 ± 0.0304	0.0230 ± 0.0118
4	Nalhera	Late Harappan site	0.200 ± 0.0311	0.2162 ± 0.0032	0.0162 ± 0.0125
5	Satikund	O.C.P.	0.0394 ± 0.0042	0.0495 ± 0.0051	0.0101 ± 0.029
6	Purola	P.G.W.	0.0582 ± 0.0115	0.188 ± 0.00121	0.1298 ± 0.031

have shown that the occupational deposits of OCP and Late Harappan sites in the Ganga-Yamuna Doab are quite small and thin suggesting therefore that these sites are representative of brief periods of occupation (Dikshit 1979; Deshpande 1977; Gaur 1969). In the light of the above results it would prove interesting to investigate the phosphorus levels of a large number of excavated OCP sites of the Ganga-Yamuna Doab and to study the results against the background of the

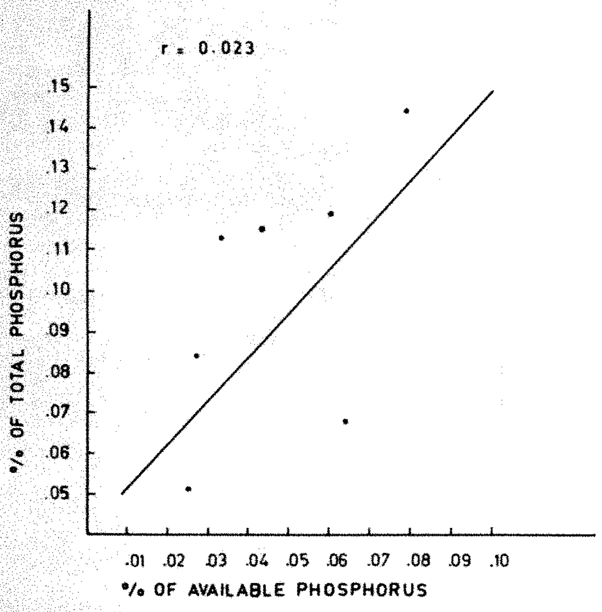

Fig. 4: Scattergram of the relationship between the percentage of total phosphorus and available phosphorus in the stratified deposits of the PGW site at Purola

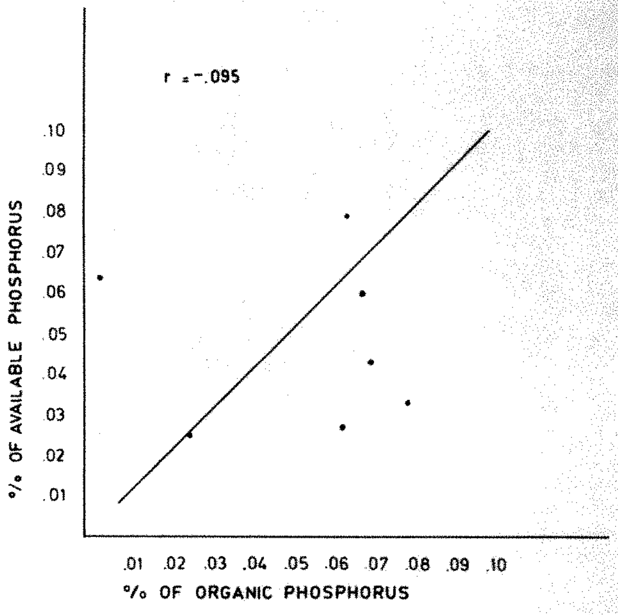

Fig. 5: Scattergram of the relationship between the percentage of available and organic phosphorus in the stratified deposit of the PGW site at Purola

depositional history of OCP sites which has been highlighted by previous workers (Lal 1968; Ahmad 1988; Agrawal *et al.* 1977).

Conclusion

On the basis of the present study it may be concluded that the level of organic (anthropogenic) phosphorus reaches its maximum value of 0.080% at a depth of 0.75 m, between layer 2 and 3, corresponding to the floor level and shows a decreasing trend towards its lowest value of 0.02% in the natural soil. The trend concerning the content of organic phosphorus, therefore, indicates intense activity during the late phase of the Painted Grey Ware (PGW) settlement at Purola.

The correlation between different fractions also confirms that the total phosphorus is enriched by organic (anthropogenic) phosphorus at the floor level (Fig. 1).

Estimation of the values of phosphorus from the different explored sites also yielded positive results, thus proving the usefulness and importance of this method of analysis in archaeological investigations.

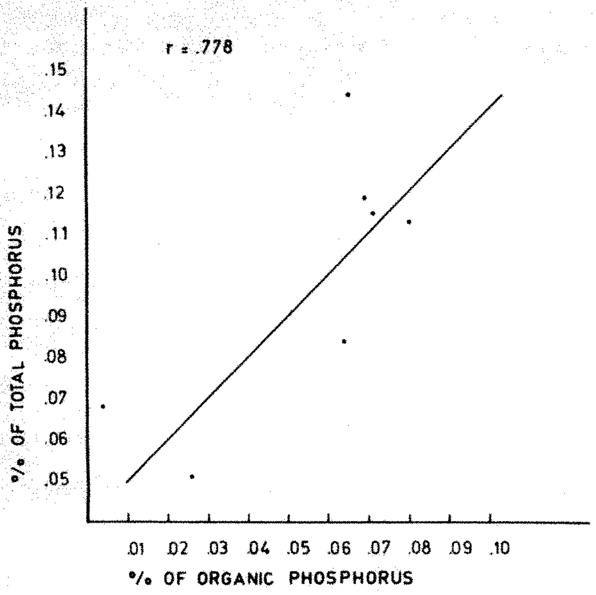

Fig. 6: Scattergram of relationship between the percentage of total phosphorus and organic phosphorus in the stratified deposit of the PGW site at Purola

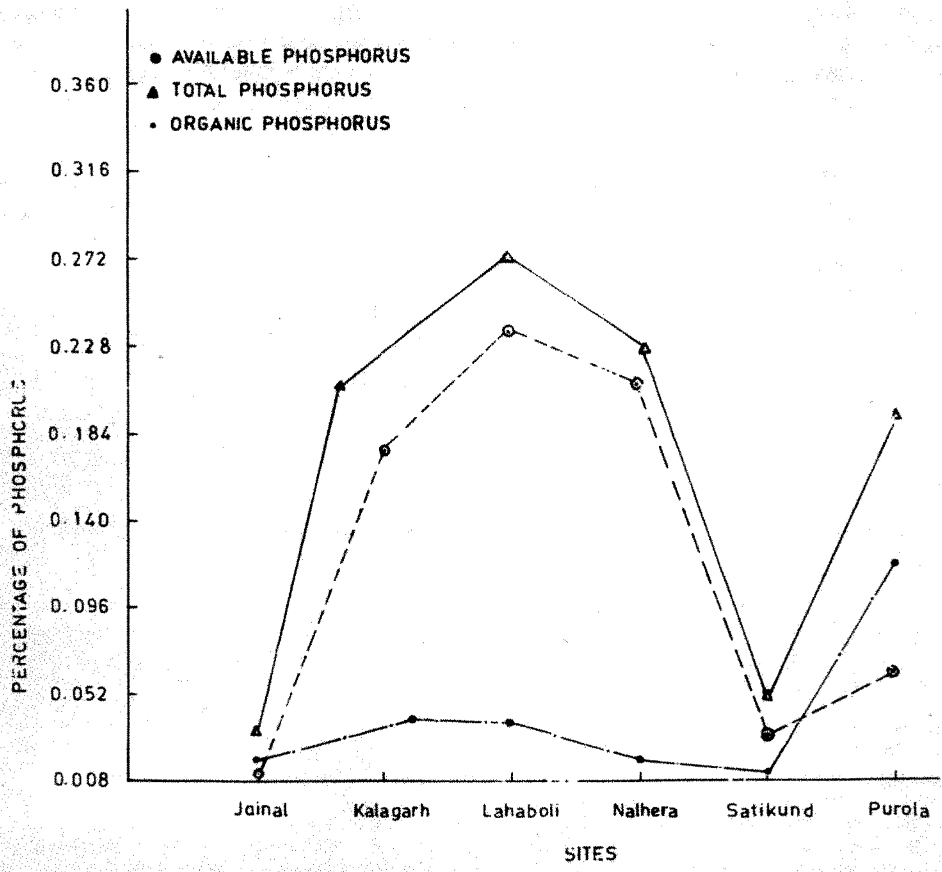

Fig. 7: Comparative values of different fractions of phosphorus from archaeological sites

Acknowledgement

The authors express their gratitude to Prof. K.P. Nautiyal, Co-ordinator, DRS Programme, for his constant help and encouragement during these investigations, and also for revising the manuscript. Thanks are also due to Dr. B.M. Khanduri, Dr. Rakesh Bhatt and Dr. Atul Saklani for valuable suggestions and help during the preparation of this manuscript. We also thank Shri Jagdeep Singh Negi for preparing the line drawings. The present work has been carried out under the DRS Programme of the UGC and their financial assistance is duly acknowledged.

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Ancestry of *Bos* species: Myth and Reality IV. The Origins of Humped Cattle

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Abstract

Ancient wild cattle were widely distributed and divided into a number of species and subspecies. It is likely that the ancestor of cattle all over the world was a humpless form which later gave rise to various subspecies. The origin of humped cattle in Asia was possibly coupled with a mutation of the gene responsible for controlling the size of the hump. The extinction of wild cattle during the Holocene in India cannot be explained as a result of either environmental factors or over-hunting. The mechanism of intra-specific competition had possibly replaced the ancient wild form in Asia. Thus the zebu probably originated from one of the subspecies of *Bos primigenius*. The very idea of the extinction of *Bos namadicus* appears to be without proper foundation.

Introduction

In the earlier parts of this series, various problems relating to the ancestry of *Bos* species were discussed in order to construct the necessary logic for the ancestry of *Bos* species in India (Joglekar and Thomas 1990a and b, 1991). This paper attempts to synthesize the conceptual basis for the origin of humped cattle in Asia and the following points summarize the conclusions drawn so far.

1. The genetics of cross-breeding indicate that the Indian humped cattle and the European humpless form belong to one genetic unit (Joglekar and Thomas 1990a).
2. Morphological characters such as the hump and the size and shape of the horncore are not necessarily markers of species separation (Joglekar and Thomas 1990b).
3. Multivariate morphometry revealed that several ancient forms of bovines are not distinguishable as different species (Joglekar and Thomas 1991).

Bovine Phylogeny

It has been well established that various subspecies of *Bos primigenius* had a common ancestor. The continuation of the branch giving rise to European cattle (*Bos primigenius taurus*) has been demonstrated with the help of skeletal features (Grigson 1985) as well as by reconstruction experiments on modern aurochs (Heck 1951). The major problem associated with the continuity of the humped zebu cattle is the absence of evidence of the hump in the ancestral form (*Bos primigenius namadicus*). Consequently one has to start with two alternative propositions:

Alternative I: The common ancestor of both Indian and European cattle was **humped**. It continued to produce the humped zebu in India, whereas the humpless form developed in Europe.

Alternative II: The common ancestor of both Indian and European cattle was **humpless**. The ancestral humpless form continued to be produced in Europe, while the humped form developed in Asia.

It is necessary to consider the all available evidence to support or negate either of the two propositions. The genetics of the hump is, however, of critical value in solving the problem. Bokonyi (1974) and Merkow (1973) have suggested that the origin of cattle all over the world can be traced back to the ancestral form called *Bos planiform*, which migrated from Asia to Europe and North Africa. It reached Europe crossing the Mediterranean. The connecting link between the Asiatic and the European form was hypothesised by Hilzheimer (1917) to be *Bos primigenius hahni*. This was elevated to species rank by Lehman (Boessneck 1957). Whatever may be the taxonomic status of the connecting link, separation occurred sometime during the

Upper Pleistocene (Pilgrim 1939). However, there is no record of the aurochs (*Bos primigenius primigenius*) in Europe till the Lower Pleistocene (Zeuner 1963). This means that the separation took place sometime during or before the Early Pleistocene period.

The presence or absence of a hump in the European aurochs would indirectly indicate whether this feature occurred or not in the stock prior to its separation from the Asiatic stock. The Late Pleistocene (Upper Palaeolithic) cave drawings at Lascaux and other caves in France show that the aurochs were humpless (Zeuner 1963; Leroi-Gourhan 1968). The cattle which migrated to Africa were also derived from the Asiatic stock, and the stone age cattle in Africa were humpless (Bandi *et al.* 1961). Cattle at the time of the Pharaohs were humpless and there is no direct evidence for humped cattle in North Africa till as late as the second century B.C. (Lydekker 1912; Marshall 1989). Thus the above evidence points to the humpless condition of the original cattle stock and it would appear that only the Asiatic form developed a hump.

There is no direct evidence for the presence or absence of a hump in *Bos primigenius namadicus*. If one accepts that the 'Unicorn' is meant to represent wild cattle as suggested by Mackay (1973), that form too was humpless. At the same time there is definite evidence for the presence of the humped form in the Indus valley culture (Dasgupta 1945). The earliest evidence for humped cattle has been found in the sixth millennium B.C. at Mehrgarh by Meadow (1984) and the fourth millennium B.C. at Rana Ghundai in Baluchistan (Epstein and Mason 1984). Thus humped cattle probably made their appearance around 5800 B.C., contemporary with the longhorn humpless form found at Catal Hoyuk (Perkins 1969).

In India, pictorial evidence for humped cattle is found in the form of Harappan seals in the mid-third millennium B.C. and also from various cave paintings from Manchaja, Kharwari and Jaora in Madhya Pradesh during the Chalcolithic period (Neumeyer 1983). At Bhimbetka, Madhya Pradesh, there is clear evidence of a humped bull in Cave III F-24 (Mathpal 1984), but the uncertain chronological position of the paintings prevents more precise dating. Thus it can be concluded that domestic humped cattle appeared not earlier than the third millennium B.C. in India, although present in the Middle East for about two millennia prior to that.

Origin of the Hump

The hump may possibly have some value in terms of physiological adaptability to the tropical climate (Sunderesen 1976) and thus can be assumed to be a trait connected with tropical environments. A new trait like the hump can develop in a number of ways, e.g., mutation and a recombination of genes (Merryl 1963). The mutation, if dominant gets 'fixed' against its recessive counterpart. If a gene h has mutated to the dominant hump producing form (**H**) the new gene frequencies according to the Hardy-Weinberg equilibrium will be as noted below:

Initial Genotype	**HH**	**Hh**	hh
Initial Gene Frequency	p^2	$2pq$	q^2
Fitness Value	1	1	$(1-S)$
New Gene Contribution	p^2	$2pq$	$q^2(1-S)$

S stands for the value of selection against the wild gene, which can vary between 0 (no selection value) and 1 (complete selection value). In the latter case (S=1), the gene frequency changes during the successive generations are as follows:

Generation	Frequency of h
0	qo
1	$q1=qo/(1+qo)$
2	$q2=q1/(1+q1)$
3	$q3=q2/(1+q2)$
4	$q4=q3/(1+q3)$
n	$qn=(qn-1)/[1+(qn-1)$

Thus the mutant gene **H** is said to be 'fixed' when qn approaches zero (but never exactly zero) and the recessive gene h is almost eliminated from the population. The number of generations required for the fixation varies in wild animals (e.g., randomly mating populations). In domestic farm animals, however, the time is considerably shorter (Falconer 1982). If the initial mutant appears in a randomly mating population consisting of 100 individuals, the mutant will get 'fixed' in 320 generations (Kimura and Ohta 1969). This calculation is based on the assumption that the mutant is completely dominant and the selection factor (S) operates in such a way as to favour its survival. If the mutant is partially dominant or co-dominant (and possibly this is the case with the hump), the necessary Hardy-Weinberg equilibrium will be maintained but in a different manner as compared to the completely dominant mutant gene (Falconer 1982). With the generation interval being 6-8 years in cattle (Payne 1970), a mutant form in cattle is likely to be 'fixed' in about 2000-2600 years. Possibly this was what happened in the case of the development of the hump in cattle. Also along with the mutation, domestication could have accelerated the fixation of the hump as has been suggested by Haldane (1949) and Franklin (1987) for other mutants in the case of certain farm animals.

Extinction of Wild Cattle

The extinction of a megafaunal species like *Bos*, needs to be explained with possible biological mechanisms. The extinction of a species can be explained as a result of one or many interactive factors that modulate the gene pool and its survival value over a long period of time. The possible reasons could be large body size, over-hunting, intra-specific competition and climatic conditions, but such explanations should consider the cautionary doubt put forward by Diamond (1989).

The body size of the Asiatic aurochs (although smaller than its European counterpart) was possibly larger than the present day domesticated cattle found in India. The presence of such large sized animals like the buffalo, rhinoceros and hippopotamus has been established in the Baghor Formation approximately between 26000-10000 years B.P. (Clark and Williams 1986). If body size was the factor responsible for selective elimination of large sized animals, it would have operated on all such animals and not specifically on wild cattle.

The Holocene climate was wet, warm and with a well distributed pattern of summer and winter rainfall (Clark and Williams 1986) indicating the absence of conditions adverse to ruminant survival. The wet climate continued till the mid-Holocene (6000-3000 B.P.) in parts of Western India (Abhyankar 1987) and even the arid climate of Rajasthan witnessed one high rainfall period during the late Holocene, approximately between 5000-3000 years B.P. (Singh *et al.* 1974). The climate during the Holocene in general was also not harsh enough to have adversely affected the survival of the megafaunal species and thus there is no reason to conclude that the climatic conditions during or before the Holocene have been responsible for the extinction of wild *Bos* species from India.

A species can also be eliminated due to over-hunting by man. When the number of animals being born falls short of the number of animals dying naturally or by hunting, the population moves towards the path of extinction (Diamond 1989). However, the over-hunting has to be a constant process over a period of time and spread over a large area. There are examples of auroch hunting on a large scale in Europe during the Early Historical Period (Bokonyi 1974). The European wild auroch was a massive animal and hunting such an animal was never an easy task or an isolated individual attempt. There may have been sporadic instances of the hunting of large animals during the Historic Period in India, but there is not sufficient evidence to prove that large animals were hunted during the prehistoric period on a scale large enough to eliminate the species from the whole of the Indian sub-continent.

If one combines all the available evidence, the question still remains as to why wild cattle, if not extinct, are not reported during the Holocene. At almost all the sites of the Pleistocene period, there are no animal remains and therefore the problem of extinction itself is more conceptual than real. The term 'extinction' needs to be reconsidered in the context of Indian prehistoric studies as related to the *Bos* species. Thus it is suggested that wild cattle in India did not become 'extinct', instead they survived at least till the mid-Holocene and then genetically continued as modern domestic cattle.

Conclusions

Thus to conclude this series on the ancestry of *Bos* species, the following points may be noted.

1. The usage of *Bos namadicus* and *Bos indicus* as distinct species should be discontinued.
2. *Bos namadicus* need not be used as an index fossil as it no longer has any meaning as a distinct unit.
3. The whole terminology related to the extinction, speciation, domestication and the origin of zebu cattle needs to be re-examined from the point of view of the modern synthesis of evolutionary biology rather than classical palaeontology based on typological studies.

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Neolithic Faunal Remains from the Central Pennar Basin, Cuddapah District, Andhra Pradesh

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Abstract

A report on faunal material discovered during explorations and trial excavations in Cuddapah District, Andhra Pradesh, 1986-1990.

Introduction

This paper describes the faunal material found during the course of trial excavations and explorations carried out over four seasons (1986-90) in the central Pennar Basin, Cuddapah District, Andhra Pradesh. A total of 47 Neolithic sites were brought to light by extensive village-to-village surveys (Venkatasubbaiah 1988). The area covered by these sites varies from 0.06 to 3.45 hectares, while the thickness of the cultural debris varies from 0.5 to 2 m.

The Neolithic settlements are located in the northwestern region of the black soil plain, in the district of Cuddapah (Fig. 1) and are largely confined to the nallas and minor tributaries rather than the main Pennar river.

Explorations

The faunal material was collected from seven Neolithic sites, viz. Hanumantaraopet (HRP), Vaddirala (VDR), Jangalpalle (JGP), Inagaluru-I (ING-1), Peddamudiyam (PMD-2), Balijapalle (BJP-P) and Nagarajupalle (NRP). What follows is a brief account of the surface finds at these sites.

Apart from the animal bones, the cultural material, at these sites includes pecked- and ground- stone artefacts and blade tools, pottery of a variety of fabrics, beads and bone tools. The faunal material revealed the presence of a variety of domestic and wild animals and molluscan shells (Table 1).

Four domestic species dominate, i.e. cattle, buffalo,

Table 1: Faunal material from surface explorations in Cuddapah District

Species	HRP	VDL	JGP	ING	PMD	BJP	NRP	Total	%
Bos indicus	16	30	46	45	39	21	23	220	65.28
Bubalus bubalis	02	-	-	-	09	01	02	14	4.15
Capra/Ovis	09	03	04	05	09	06	03	39	11.58
Boselaphus tragocamelus	-	02	-	-	-	-	-	02	0.59
Antilope cervicapra	-	-	-	-	03	03	01	06	1.79
Axis porcinus	-	-	-	-	-	01	-	01	0.29
Muntiacus muntjak	01	-	-	-	-	-	-	01	0.29
Gallus domesticus	05	-	-	-	04	-	-	09	2.68
Macrochlamys infinsta	05	-	-	-	-	-	-	05	1.48
Pila globosa	-	06	09	-	06	05	-	26	7.72
Lamellidens sp.	-	-	-	-	07	07	-	14	4.15
Total NISP	38	41	59	50	77	43	29	337	
Unidentifiable fragments	11	10	06	-	-	-	06	33	
Total Bone Count	49	51	65	50	77	43	35	370	

% Calculated with respect to total number of identified specimens (NISP)

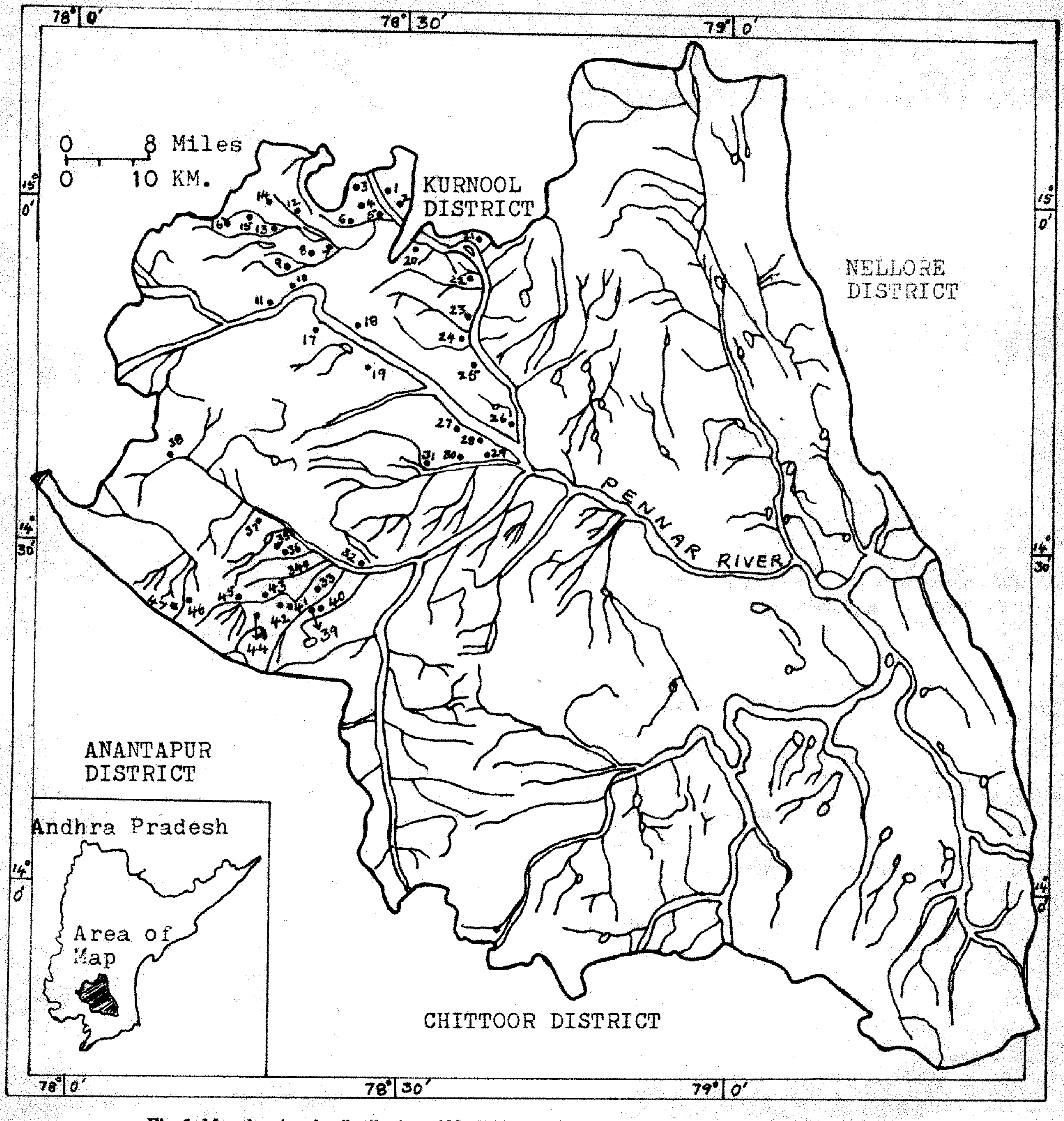

Fig. 1: Map showing the distribution of Neolithic sites in the Central Pennar Basin, Cuddapah District

Site List:

1. Peddamudiyam-1; 2. Peddamudiyam-2; 3. Nagarajupalle; 4. Paluru-J; 5. Chinnamudiyam; 6. Boditippenapadu;
7. Bodupalle; 8. Hanumantaraopet; 9. Torrivemula; 10. Veparala; 11. Mylavaram; 12. Kamballadinne; 13. Madhavapuram;
14. Jangalapalle; 15. Vaddirala; 16. Dannawada; 17. Gudemcheruvu; 18. Danavulapadu; 19. Kanyathirtham; 20. Vellala;
21. Idamadaka; 22. Gadeguduru; 23. Tondaladinne; 24. Upparapalle; 25. Chapadu; 26. Vedururu; 27. Kokatam;
28. Sambaturu; 29. Akkempeta; 30. Tippaluru; 31. Koduru-K; 32. Ramireddipalle; 33. Balijapalle-P; 34. Paluru-P;
35. Inagaluru-1; 36. Inagaluru-2; 37. Koraguntapalle; 38. Nidivelagala; 39. Chagaleru-1; 40. Chagaleru-2; 41. Gollalaguduru-1;
42. Gollalaguduru-2; 43. Timmapurampeta; 44. Bokkudupalle; 45. Ulimella; 46. Kottapalle; 47. Kottagundavaripalle

sheep/goat and fowl, and account for about 4/5th of the total number of bones. Among these, cattle constitute the largest number followed by sheep/goat.

The wild fauna consists of two species of antelope and two species of deer. Nilgai and blackbuck are the ones mainly found in the semi-arid tropics (Prater 1965). The deer species have been found only at Balijapalle which would suggest the presence of woodland areas near the site during the Neolithic period.

A majority of the exposed bones have been subject to sub-aerial agencies, in addition to a large number of bones showing longitudinal fissures and the impact of trampling. Consequently, only a few bones could be measured.

The site of Nagarajupalle was the only one of the seven from which bones could be measured (Table 2), but even these measurements are too few to use for statistical tests. They are, however, consistent with the present day measurements of domestic cattle.

Table 2: Measurements of the bones collected from Nagarajupalle

Species	Bone	Measurements (mm)	
Bubalus bubalis	Astragalus	GLl	70.15
		GLm	63.85
		Bd	46.67
		Dl	37.54
Bos indicus	Astragalus	GLl	62.06
		GLm	57.02
		Bd	37.50
		Dl	32.34
		Dm	32.81
Bos indicus	Centrotarsal	GB	52.06
Bos indicus	First Phalanx	GL	61.96
		Bd	30.96
		Bp	32.31
Bos indicus	First Phalanx	GL	57.55
		Bd	23.96
		Bp	25.00

GLl=greatest lateral length; GLm=greatest medial length; Bd=distal width; Dl=lateral thicknes; Dm=medial thickness; GB=greatest breadth; GL=greatest length; Bp=proximal width

It is not possible, on the basis of the surface finds alone, to draw inferences regarding the food economy at these sites. However, the trends in the faunal data point to a pastoral economy based mainly on cattle and buffalo. The inhabitants of these sites might also have exploited the available faunal wealth around the sites in order to supplement their energy-protein requirements. The sites have also yielded evidence of a variety of plants (Venkatsubbaiah and Kajale 1991). Thus all the available evidence taken together and related to the subsistence strategies of Neolithic peoples, would indicate that a mixed subsistence economy was also practiced by Neolithic habitants of this region.

Section Scrapings

Trial excavations were carried out at three Neolithic sites, viz. Hanumantaraopet (HRP), Peddamudiyam (PMD-2) and Balijapalle (BJP-P). The aim was to ascertain whether the archaeological and faunal material found on the surface extended below the surface also.

(i) Balijapalle (14° 29' N : 78° 20' E)

The monocultural Neolithic habitation of Balijapalle measures 180x120 m. Two trial trenches were excavated in the northeastern portion of the mound. Trench I (2.5x2.5 m) was dug to a depth of 1.40 m, but the cultural debris was only about 90 cm thick and divisible into five layers. Trench II (1x1 m) was dug to a depth of 1.35 m, with a cultural deposit 1.10 m thick and also divisible into five layers. Both the trenches yielded a variety of pottery, stone artefacts, etc. (Table 3).

Table 3: Distribution of the archaeological finds at Balijapalle

Artefact	Trench I			Trench II		
Layer	2	3	4	2	3	4
Black-on-red ware	+	+	+	+	+	+
Brown ware	+	+	-	+	-	-
Unburnished red ware	+	-	-	-	-	-
Grey ware	+	+	+	+	+	-
Black ware	+	-	-	-	-	-
Buff ware	-	+	-	-	-	-
Coarse red ware	-	-	-	-	+	-
Microliths	+	+	-	+	+	-
Stone artefacts	+	+	-	+	-	+
Beads	-	+	-	-	-	-

(ii) Hanumantaraopet (14° 55' : N 78° 22' E)

The Neolithic habitation site of Hanumantaraopet is 12.5 km north of Jammalamadgu town. The habitation covers an area of 230x150 m. No radiocarbon dates are available from this site.

Two trial trenches were excavated. Trench I (3x3 m) was dug in the centre of the mound and revealed habitational debris of about 1.98 m, comprising six layers. Trench II (1x1 m) was laid to the southwest of Trench I and was dug to a depth of 1.95 m. This trench also revealed the presence of six layers and a variety of cultural material (Table 4).

Table 4: Distribution of the archaeological finds at Hanumantaraopet

Artefact	Trench I						Trench II		
Layer	1	2	3	4	5	6	2	4	6
Coarse Red ware	+	-	-	-	-	-	-	-	-
Unburnished Red ware	+	+	+	-	-	-	+	-	-
Brown ware	+	+	-	+	+	-	-	+	-
Grey ware	-	+	+	+	+	+	+	+	+
Black-and-Red ware	-	+	-	-	-	-	-	-	-
Black-on-Red ware	-	+	+	+	+	+	+	+	+
Burnished Red ware	-	+	-	+	+	+	-	+	-
Buff ware	-	+	+	+	+	-	-	+	-
Black ware	-	-	+	-	-	-	-	-	-
Microliths	-	+	-	-	-	-	-	-	-
Stone artefacts	-	-	-	-	-	-	-	+	-
Beads	-	+	-	-	-	-	-	-	-

(iii) Peddamudiyam (15° 00' N : 78° 28' E)

The monocultural Neolithic site of Peddamudiyam is located 21 km east of Jammalamadgu town. Only one trial trench (3x3 m) was excavated to a depth of 55 cm. This trench has revealed the presence of three layers composed of a variety of pottery, microliths and other stone artefacts (Table 5). Two radiocarbon dates are available from this site, i.e. 3490±90 B.P. (1540 B.C.) from layer 3 based on a half-life of 5730 years and 3060±120 B.P. (1110 B.C.) based on a half-life 5570 years from layer 2.

Table 5: Distribution of the archaeological finds at Peddamudiyam

Artefact	Trench I		
Layer	1	2	3
Burnished Red ware	+	+	+
Unburnished Red ware	+	+	+
Brown ware	-	+	-
Buff ware	+	+	-
Grey ware	+	+	+
Black ware	+	-	-
Black-on-Red ware	+	+	+
Microliths	+	+	+
Stone artefacts	-	+	-
Beads	-	+	-

The excavations at these three sites have yielded a large number of fragments of bones and shells. A few of the fragments were identifiable (Table 6).

Table 6: Faunal material from the excavated sites in Cuddapah District

Species	HRP	PMD-2	BJP-P	NRP
Bos indicus	51	20	28	9
Capra/Ovis	15	2	7	1
Gallus domesticus	2	-	-	-
Antilope cervicapra	-	-	9	1
Axis axis	2	-	-	-
Pila globosa	5	-	-	-
Lamellidens sp.	1	-	-	-
Total NISP	76	22	44	44
Unidentifiable fragments	9	8	2	2
Total Bone Count	85	30	46	11

The faunal list from the excavated material is dominated by cattle followed by sheep/goat as was noticed in the case of surface finds. Among the wild mammals, blackbuck and spotted deer have been noticed at Balijapalle and Hanumantaraopet respectively. Thus, in general the excavated material corroborates the observations made on surface finds.

Discussion

Analysis of the faunal remains from surface explorations as well as from trial excavations, revealed that the Neolithic inhabitants might have relied on cattle pastoralism. However, it is necessary to bear in mind the limitations of this sample study.

The inferences herein are based on a sample brought to the laboratory for investigations. The sample available was inadequate for the purpose of quantification which is necessary to be able to understand the subsistence strategies at these sites.

The presence of molluscan shells at these sites is interesting. The freshwater and land snails could have been used for food, but there is no concrete evidence for or against this. These shells only indicate that Neolithic people might have exploited the lake and riverine waterpools nearby either to collect supplementary dietary items like mussels or these shells could have reached the site as a result of sand having been directly transported to the sites.

In spite of the limited sample, the evidence from these Neolithic sites holds promise and further excavations will substantiate evidence for Neolithic subsistence patterns in the region.

Acknowledgements

The authors are grateful to Dr. K. Paddayya and Dr. P.K. Thomas, both of Deccan College, Pune for their encouragement and valuable suggestions.

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The Ancient Gem Industry in Cambay

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Abstract

Gem cutting in Cambay can be traced back to early historic times. This tradition appears to have continued through protohistoric, historic and medieval times to the present day with a major change in lapidary processes at the beginning of the 20th century owing to mechanisation. Some of the steps followed for manufacturing beads at the beginning of 20th century were significantly different from the present day techniques of sawing, cutting rings and hollowed objects, grinding and even tumbling. While the introduction of electricity about five decades ago also brought about considerable changes in some of the earlier, more laborious processes, others like colour enhancement by heating, shaping by chipping and perforating by using a bow-drill are some of the techniques that have continued into the present without any modification.

Introduction

Stone, has been found to be the most durable and attractive of the various types of material (e.g. bone, terracotta and stone) used for manufacturing ornamental beads. However, shaping stone into an ornamental bead is an intensely strenuous job and demands special skills (Sinkankas 1962 and Desautels 1971). Many archaeological excavations in western India have shown that hard and tough stones were cut into quite elegant shapes and given an excellent polish as far back as Harappan times (Marshall 1931; Mackay 1937; Rao 1973 and Sankalia 1974). Obviously, the art of the lapidary had attained a considerable level of perfection more than four thousand years ago in this part of the world. In fact, evidence of bead making goes back to the Neolithic period dated to the 7th/6th millennium B.C. and the tradition of cutting gemstones continues even today in some parts of western India like Cambay and Jaipur.

Location and Brief History

Cambay or Khambhat which is its local name, (22°19' N and 72°38' E) is a large town situated at the mouth of the estuary of the Mahi river which flows into the Gulf of Cambay. Excavations at Nagara, located about 3 km from Cambay, have revealed that the historical settlement dates to the early historic period (Mehta 1968) and several semi-precious stone beads were obtained from the various levels starting from the middle of the 1st millennium B.C. Arkell (1936), Shukla (1972), Janaki (1980) and Francis (1982) have given accounts of the gemstone trade which took place from this region to other parts of the world in ancient times. According to Janaki (1980), Cambay became a major trading centre in the 11th century A.D. and international trade was at its peak during the 15th century A.D. Gemstones were among the important items processed locally and then exported. It appears that the most abundantly exported stones were beads of cryptocrystalline silica. Even today the majority of Cambay's population is engaged in various lapidary processes. However, the earliest evidence of bead manufacturing in these parts has been found at the Harappan port town of Lothal which is situated at a distance of about 40 km west of Cambay. The tradition continued in the late and post Harappan times (Rao 1986).

The Gem Industry in Cambay

Stone work at Cambay can be broadly divided into two: (1) the cutting and polishing of precious and semi-precious stones and (2) the production of ornamental beads and carved objects from semiprecious stones.

Present-day bead making processes have been described by many authors among them Possehl (1981) and Karanth (1988). The present paper illustrates the various steps followed in gem cutting at the turn of the 19th century.

Though Arkell (1936) had explained some of these steps, a complete picture of bead making fails to emerge. The lapidary processes explained here are based on: (a) the descriptions given by the aged lapidaries of Cambay who had seen and practised the procedures; (b) a study of the discarded instruments used in earlier days and (c) an examination of the ancient instruments which have been modified to work on electric motors. Of the various steps explained, colour enhancement and chipping and perforation are processes that are continued even today without any modification.

Raw Material

The semi-precious stones used in the ancient bead industry included the silica group of minerals, garnet, turquoise, lapis lazuli and certain feldspars like moonstone and amazon stone. Of these, the silica group, especially the cryptocrystalline varieties were used extensively in Cambay.

Interestingly, though the bead industry has been flourishing for several centuries, the raw material is not mined in the immediate vicinity of Cambay. It is obtained from a few places located within a radius of about 150 kms of Cambay. In earlier days a major part of the material was received from the Ratanpura-Jhagadia mines, situated about 15 km east of Broach (Bharuch: 21°41' N and 73°01' E). Here, the silica pebbles are found in the oligomic conglomerate deposit belonging to the Miocene period (Gadekar 1978). Most pebbles mined here are the fibrous varieties rather than the granular varieties of cryptocrystalline silica. The silica pebbles were transported in boats along the Narmada River and the Gulf of Cambay, involving a journey of about 100 km.

Of the various types of cryptocrystalline silica encountered in Ratanpura the most common are the various shades of grey to yellowish white chalcedony. Banded agates are also available in considerable quantity. The more attractive carnelian is not so common in this region. The other varieties are much rarer while chrysoprase is totally absent. However, in the Cambay bead industry all varieties of cryptocrystalline silica are loosely called agate and the local term for agate is *akik* (*aquiq*).

Carnelian, being more attractive, has a greater demand than the other varieties. The Cambay bead maker has successfully evolved a method of enhancing the dull greyish to yellowish white chalcedony into a more attractive red to orange carnelian.

Colour Enhancement

Stones with a pleasing colour and attractive structures like banding and multicoloured speckles are taken directly for bead production while the not so attractive common chalcedonies are heated in a reducing atmosphere to enhance the colour.

Heat treatment involves the pebbles being placed in an earthen pot with an earthern lid and the whole unit being buried in a pit filled with cowdung cakes/paddy husk/sawdust and fired overnight (Fig. 1). Burning in this condition produces a reducing atmosphere, which is maintained by the pit being covered loosely with a metal sheet. Slow and steady burning in such a controlled environment helps to change the colour of chalcedony into a range of shades from red to orange. This process also helps to drive off the intergranular water molecules and softens the silica which eventually makes the process of chipping much easier. The pots are taken out only when the fuel has completely burnt out and cooled. This ensures that oxygen does not enter while the silica is still hot. Finally when the pebbles are taken out, the colour of most of them has changed to various shades of red. The yellow chalcedony is transformed into a more pleasing and deeper shade of red than the grey variety. The stones are later handed over to the lapidary for further processing.

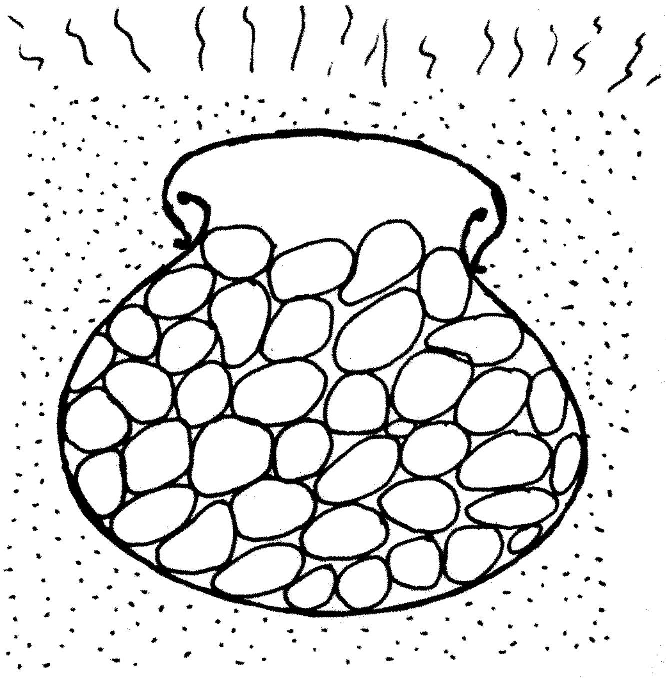

Fig. 1: Heating of chalcedony in reducing atmosphere

Chipping

The shaping of a large chunk of stone or a pebble into rough forms of beads is carried out by placing it on a pointed iron peg posted at an angle of about 30°-45° from the ground or by placing it on a pointed anvil. In the earlier days, two different kinds of hammers were used for cutting a rough bead out of the main lump and for chipping off the unwanted portions (Fig. 2). The head of the hammer was either made of buffalo horn (Fig. 2B), measuring about 5 cm x 3 cm x 5 cm or was a thick iron nail with a button head (Fig. 2A and 2C respectively). The hammer head was then fixed on to a thin long bamboo stick. More recently, however, the use of

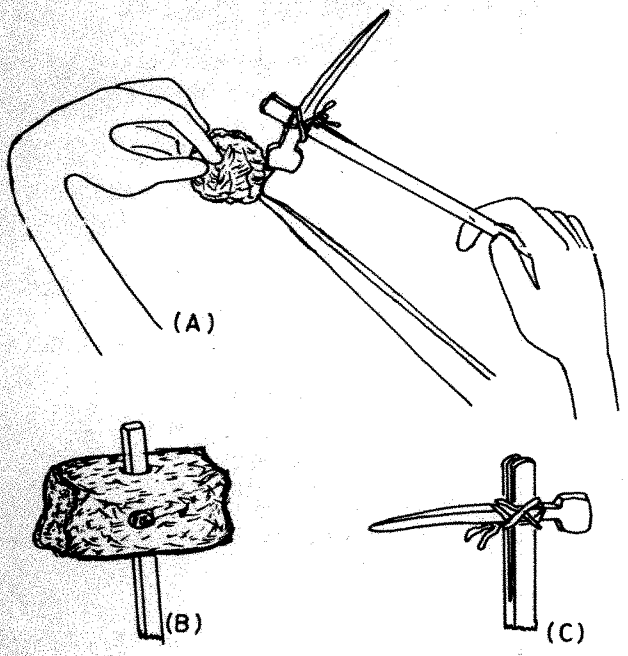

Fig. 2: Chipping: (A) Shaping of a rough bead (B) Buffalo horn bead hammer (C) Iron nail hammer with button head

the button head hammer has become almost obsolete.

With a firm blow and owing to its cryptocrystalline nature, the silica pebble breaks in the desired direction with a more or less smooth conchoidal fracture. Subsequently the unwanted portions were chipped off and the pointed splintery projections dressed as far as possible. To reduce the tedium of manual grinding, the ancient artesan probably took more care to avoid the ruggedness of pointed projections on the surface of the rough bead than does the present day lapidary. The button head iron hammer was preferred to the buffalo-horn head hammer, for the removal of pointed, splinter like projections, especially in the final stage of shaping.

Sawing

In ancient times plates and rings were made by sawing a pebble into slices of 3-10 mm by a very laborious manual process using a toothless iron saw (Fig. 3) which worked on the principle of the Chinese mud saw (Sinkankas 1962). The main job of cutting was carried out using a loose grit comprising emery powder, and a thin iron plate acted as the holder or carrier for the abrasive powder.

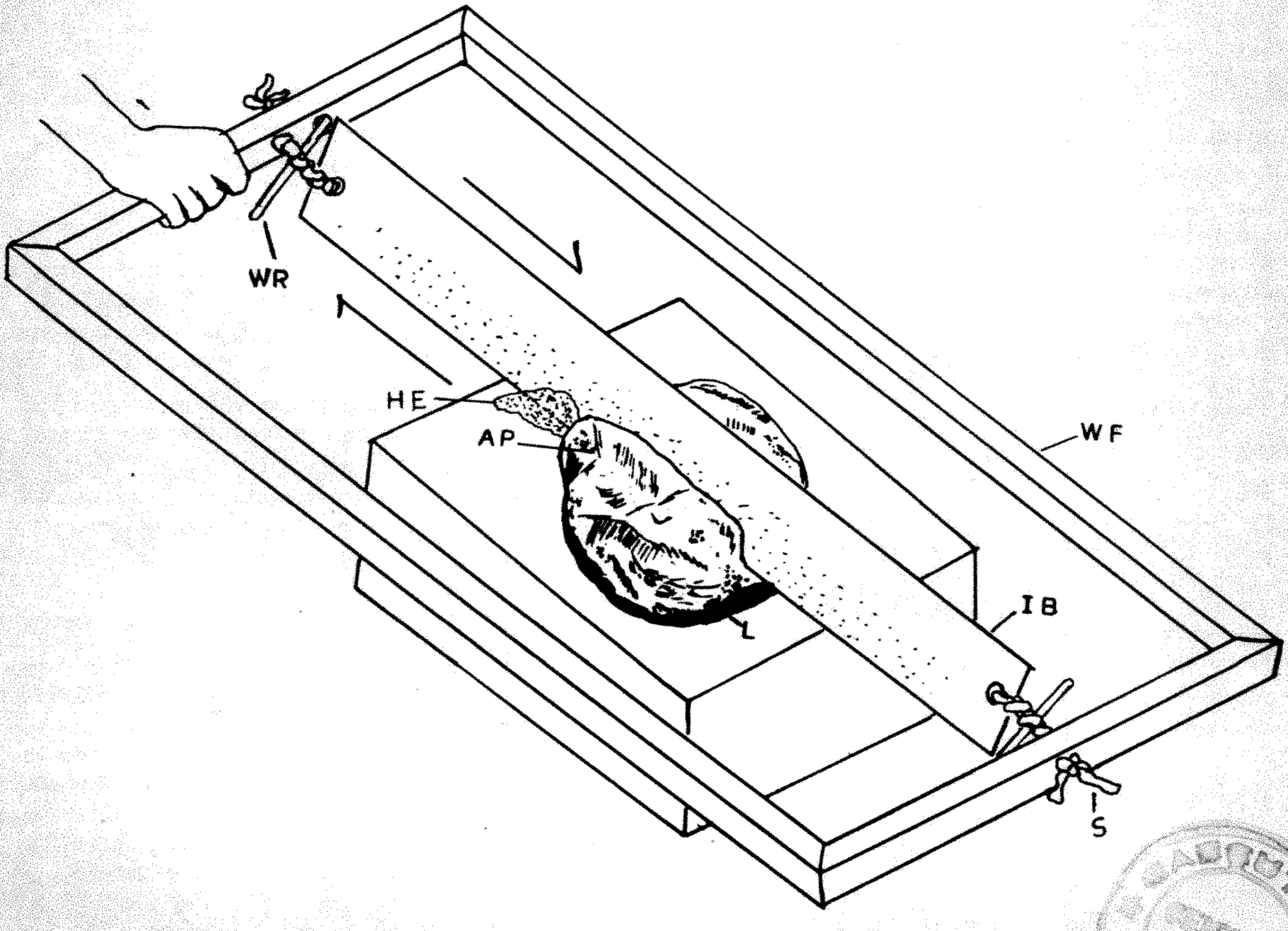

Fig. 3: Sawing: IB — toothless iron blade, WF — Wooden frame, AP — Agate pebble, L. — lac for fixing, WR — wooden rod for maintaining tension of the saw, HE — heap of emery powder

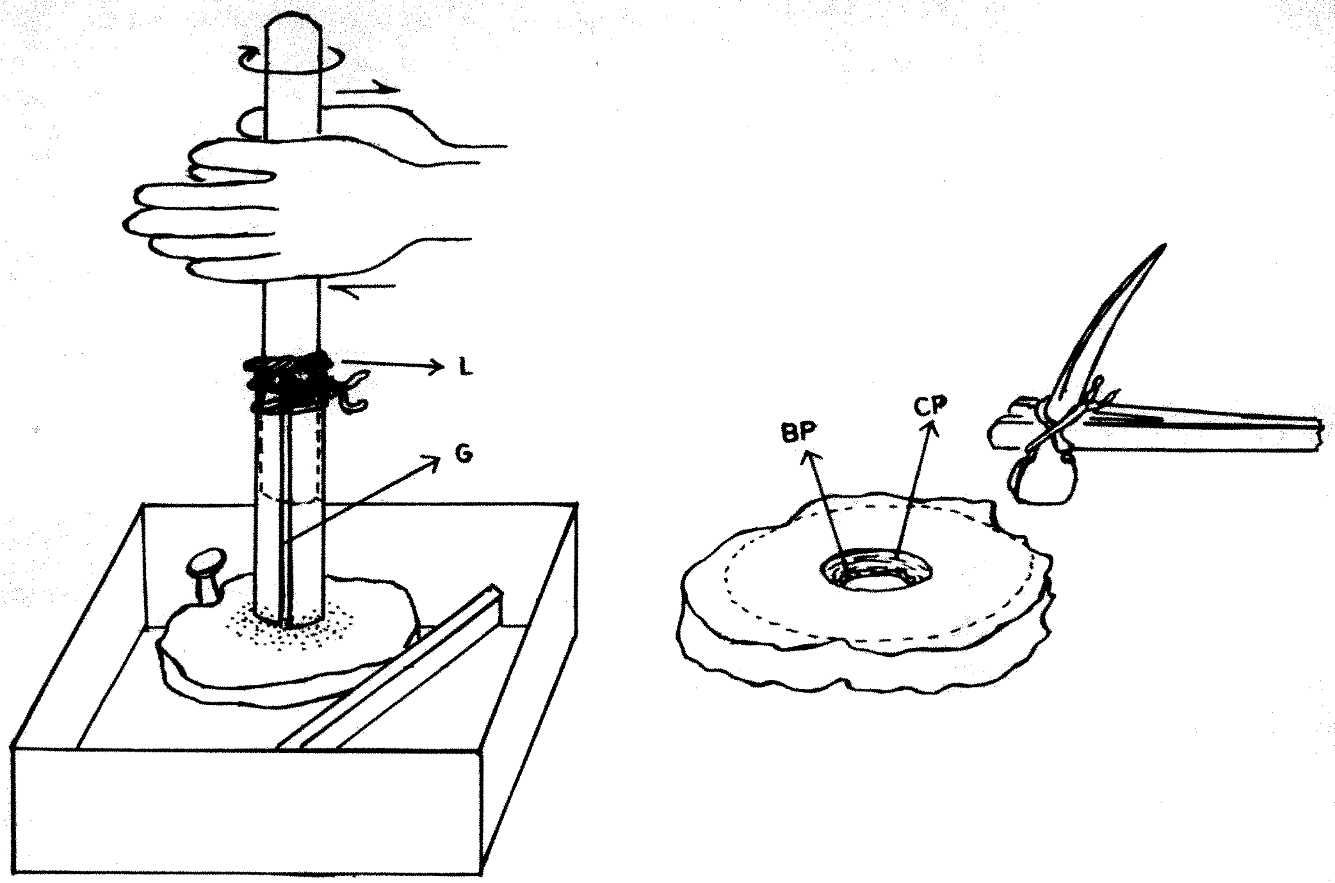

Fig. 4: Cutting a ring: (A) Cutting inner part of the ring by using hollow cylindrical toothless iron blade and loose abrasive grit; lac, G — Gap (B) Cutting outer part of the ring; CP — Portion cut by blade, BP — Forcibly broken part

A toothless iron plate about 1 mm thick, 5 cm wide and 60 cm long was used as the saw blade. It was fitted to a wooden frame with the help of a twisted cord made up of coconut or some other plant fibre. A small wooden rod or bamboo stick was turned within the twisted fibre cord and set to rest in a depression carved in the wooden frame. The required tension of the saw blade was then maintained by either tightening or loosening the twisted cord (Fig. 3).

The sample taken for cutting was affixed to a stone platform using lac or wax and the saw blade, smeared with abrasive emery powder, was moved forward and backward over it. Since the emery powder is not sticky, it was initially mixed with clay so that it adhered to the blade. The blade was passed through a small heap of emery powder placed adjacent to the stone so as to ensure a constant abrasive surface. To make a deeper cut, took several hours or even days, depending on the dimensions of the stone.

Cutting Rings

Another set of curious procedures were followed to cut rings. The slabs of agate were further cut into rings in two stages: (i) by cutting the outer edge using a button head hammer and (ii) by cutting the inner part using a hollow cylindrical toothless metal blade and loose abrasive grit.

The outer edge of the ring was cut carefully by using a hammer (Fig. 4B). As mentioned earlier, the button head iron hammer was more suitable for refined dressing than the buffalo horn head hammer and hence it was preferred.

A thin, toothless metal blade was used to cut the inner part of the ring. Initially the metal blade was folded into a cylindrical shape, leaving a thin gap (Fig. 4A). It was fixed to a wooden baton with wax or lac and was further fastened with a metal cord. Emery powder/girt was used for cutting and water was the lubricant. Through the 1-2 mm gap in the metal cylinder the loose abravise grit would collect in the groove and was then used again for cutting. Thus, this gap played an important role during the cutting of rings.

In order to reduce both time and energy, instead of cutting through the entire ring, the lapidary often followed a simple method. After cutting about 3/4 of the way through the remaining portion was carefully chiselled or hammered off. When a ring, cut in ancient times, is inspected carefully under a hand lens, the forcefully detached portion shows a conchoidal fracture on the irregularly broken surface whereas the sawed portion shows a grooved surface.

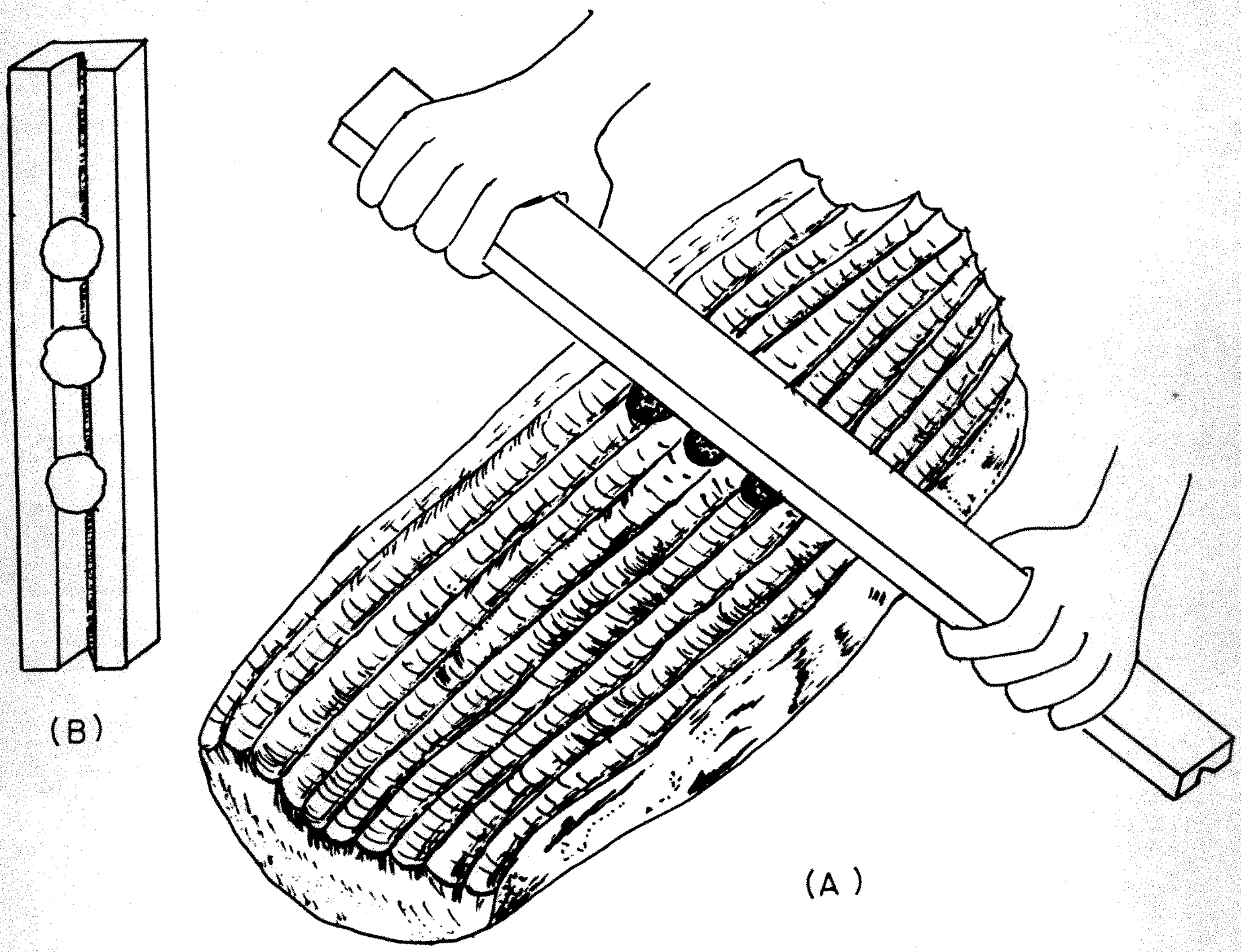

Fig. 5: Grinding of rounded beads: (A) Beads ground on a grooved sandstone slab; (B) Wooden bar with a deep 'V' cut for housing beads while grinding

Grinding

Rounded beads were ground manually on a grooved sandstone or quartzite slab (Fig. 5), whilst the faceted beads were ground on an abrasive wheel attached to a hand operated device (Figs. 6 and 7).

To grind spherical beads or beads of other shapes with rounded edges, the sandstone slab was first carved with grooves of appropriate depth. The beads to be ground were then placed in the grooves and were pressed down hard and dragged forwards and backwards several times to smoothen the surface. The device used to press and drag the beads along the sandstone groove was also quite interesting. It comprised a wooden bar into which V-shaped depression had been cut into which the beads were fitted. The bar was then pressed down on the grooved slab and moved to and fro.

To cut facets, the stones were ground on a circular emery wheel. The emery wheel was manufactured locally by the lapidary himself by cementing emery powder with lac. The emery powder was prepared by pounding corundum in small pits, cut into stones like quartzite. The powder was then passed through appropriate sieves. However, the grinding wheel was used more for cutting precious stones than for silica beads.

The grinding wheel was fixed to an axle provided with gears of three (narrow, medium and wide) different sizes. It was then placed in a circular hole cut out of a wooden table (Fig. 6). The axle was held in place by wooden frames at both the ends. Buffalo horn pieces were used in the wooden frame to wedge in the pointed metal caps fixed at either end of the axle. The horn was tough enough to allow the axle to move freely without itself being much abraded by the friction. Levelling of the grinding wheel with respect to the wooden table was extremely important for obtaining accuracy of the facets cut on stone. Especially in the case of expensive gemstones much greater care was taken to level the wheel. The axle was turned by a leather strip connected

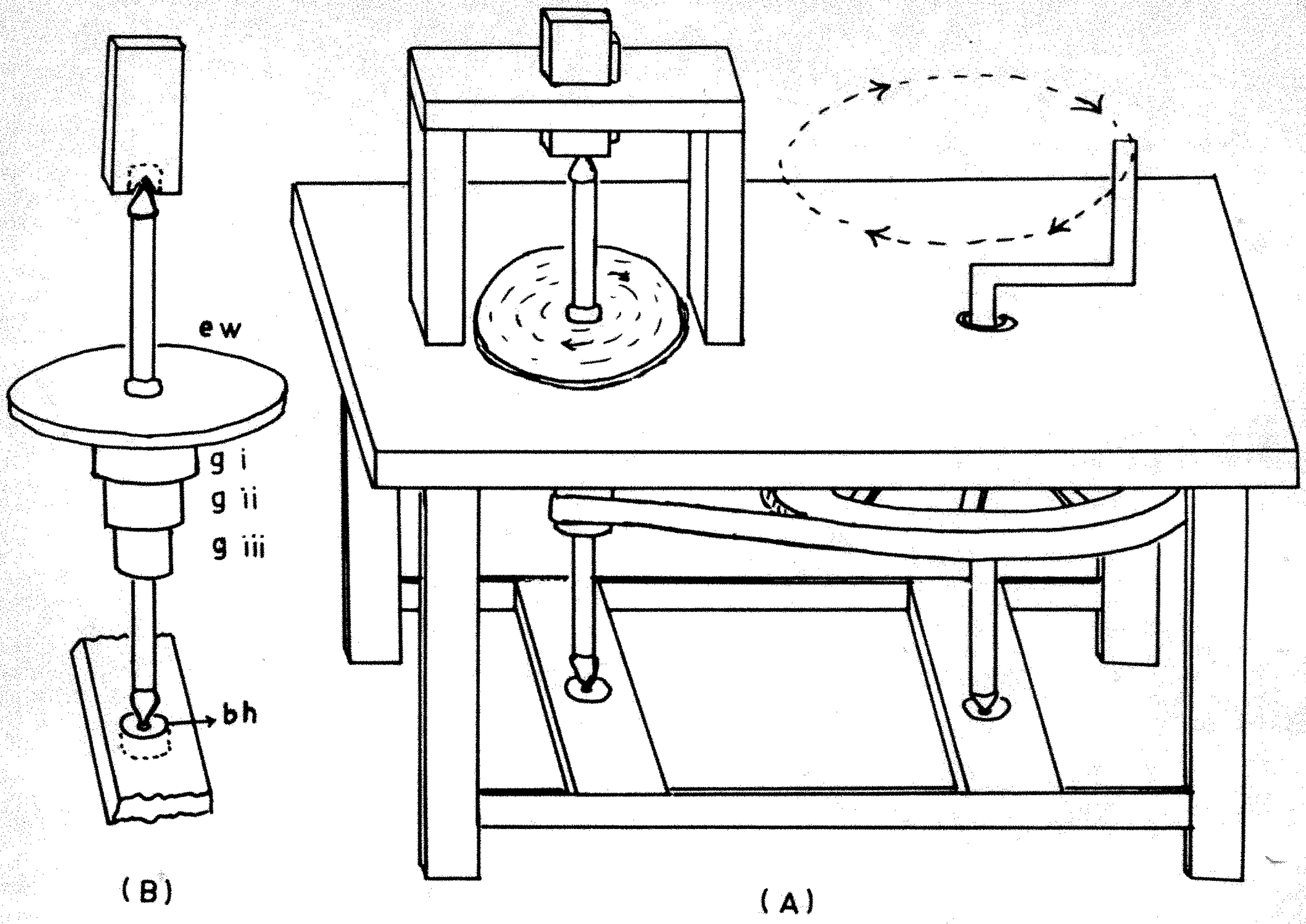

Fig. 6: Unit used for grinding faceted stones: (A) A complete unit; (B) Details of the axle; ew — emery wheel, bh — buffalo horn piece to resist abrasion and to allow a smoother movement of the axle, g i, g ii and g iii — gears with broader, moderate and narrower width respectively

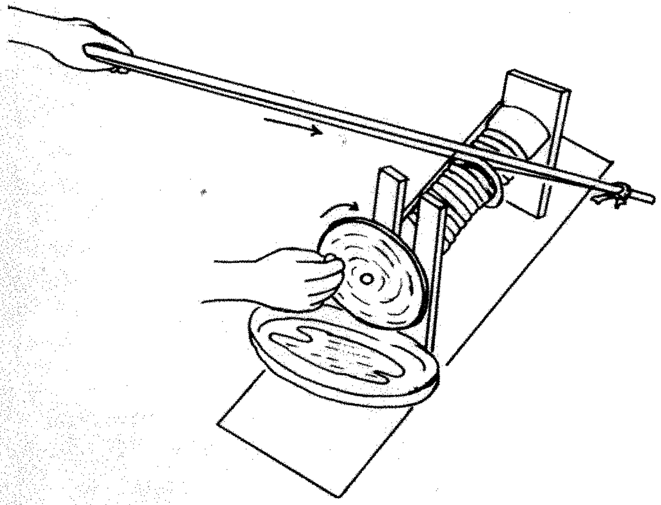

Fig. 7: Grinding faceted stone by using vertically placed grinding wheel

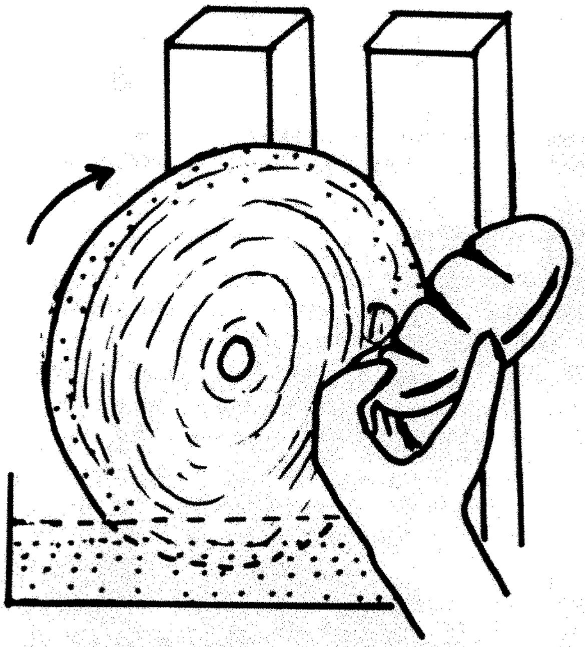

Fig. 8: Carving lines by using circular toothless metal blade and loose abrasive grit

to a large wooden wheel resembling a cart wheel. The wheel was turned manually by a handle. The RPM of the grinding wheel was controlled by attaching a leather strip to any one of the gears (Fig. 6B) for fast, moderate and slow speeds

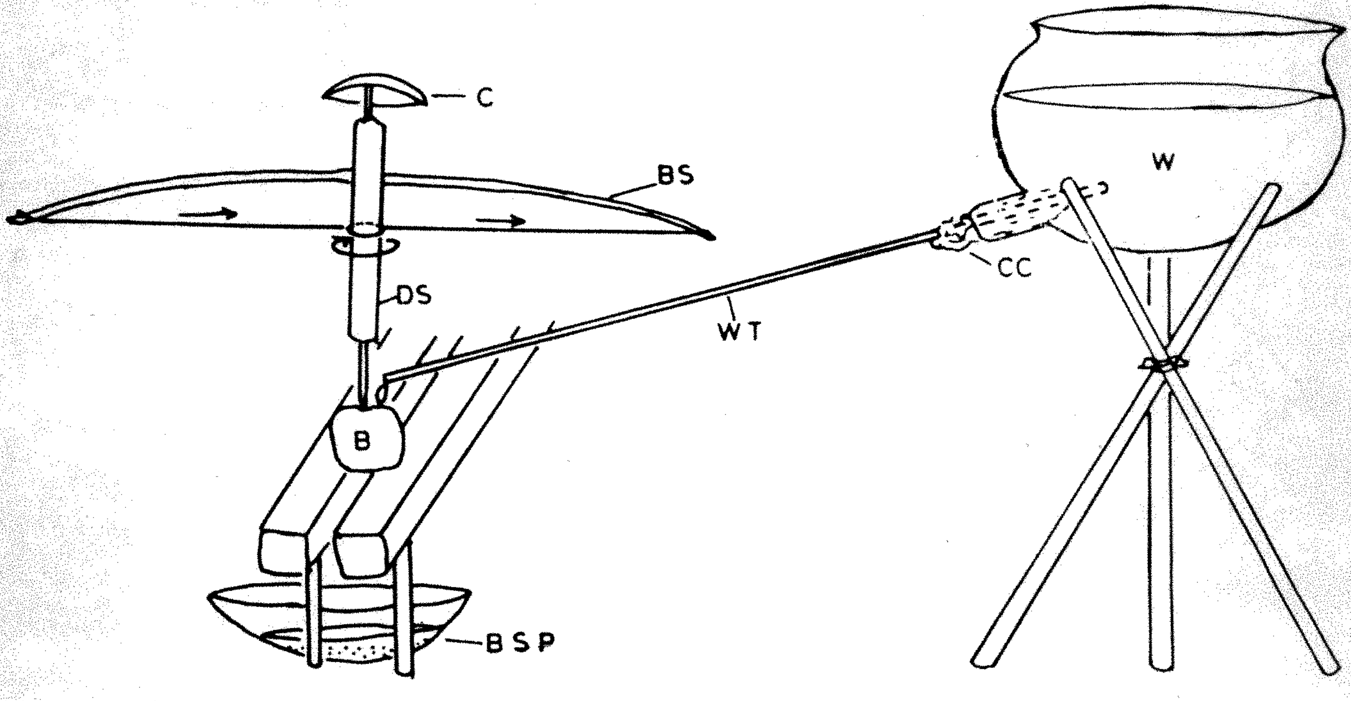

Fig. 9: Bow drill unit for perforating beads: B — bead, DS — drill shaft, BS — bow-string, WT — water transport stick, CC — cotton cloth, W — water pot, C — coconut shell for protection, BSP — bowl for collecting silica powder

respectively.

Often, a vertically placed grinding wheel was also used (Fig. 7) in which case the wheel was fixed to a horizontally placed axle and was moved with the help of a thick string that encircled it with a loop. Movement of the string was controlled by a bamboo stick to which it was attached loosely. A similar axle was also used for carving lines.

Carving Lines

Straight lines and criss-cross lines were carved on the stones using a toothless circular metal blade and abrasive powder (Fig. 8). It was driven in the same way as the vertically placed grinding wheel fixed to the horizontal axle (Fig. 7). A heap of loose abrasive grit was placed in a container at the lower part of the wheel.

To carve pitted features a diamond tipped metal rod driven by a bow-string (bow drill) was used (Fig. 9). This operation is explained in the following section.

Perforation

From ancient times through to the present, a primitive drill was used. The drill is made of a tetragonal iron stick fitted with a diamond bit. The drill shaft is driven by a bow-string (Fig. 9). One hand of the artisan presses the drill shaft against the bead while the other moves the bow. A piece of coconut shell is used to protect the hand while drilling.

To start with, the place to be drilled is marked with a single diamond bit driller and then the entire perforation is executed by using a double diamond bit perforator. The bead is drilled through from both ends. The process of drilling and the resultant features have been described in detail elsewhere (Karanth 1988 and 1990; Gorelick and Gwinnett 1989). The speed with which the artisan works is amazing. It takes less than a minute to drill a bead of one centimetre diameter. The powder scooped out while drilling silica beads is subsequently processed for polishing precious stones like rubies, sapphires and emeralds (Karanth 1989).

Polishing

Rounded beads and faceted stones were polished by entirely different methods. While the faceted stones were polished on a flat lap, spherical and beads of other shapes with rounded edges were polished by tumbling. In the case of the faceted stones and depending on their hardness (H), different laps were used, for example, a wooden lap for H 6-7, a tin lap for H 7-8 and a copper/bronze lap for H 8-9. Precious stones are polished with the silica powder obtained as a by-product from bow-drilling. Powder for polishing was also obtained by directly crushing and sieving chalcedony. Silica powder was further heated till it became milky white. The polishing lap was turned in the same way as described earlier for grinding (Figs. 6 and 7).

Rounded stone beads were polished in a metal tumbler or a leather bag. The beads, polishing powder and water were poured into a rectangular or rounded metallic drum (Fig. 10C) which was then shaken by hand for a considerable length of time. This mode of tumbling, however, is said to have been used more as a substitute for grinding odd

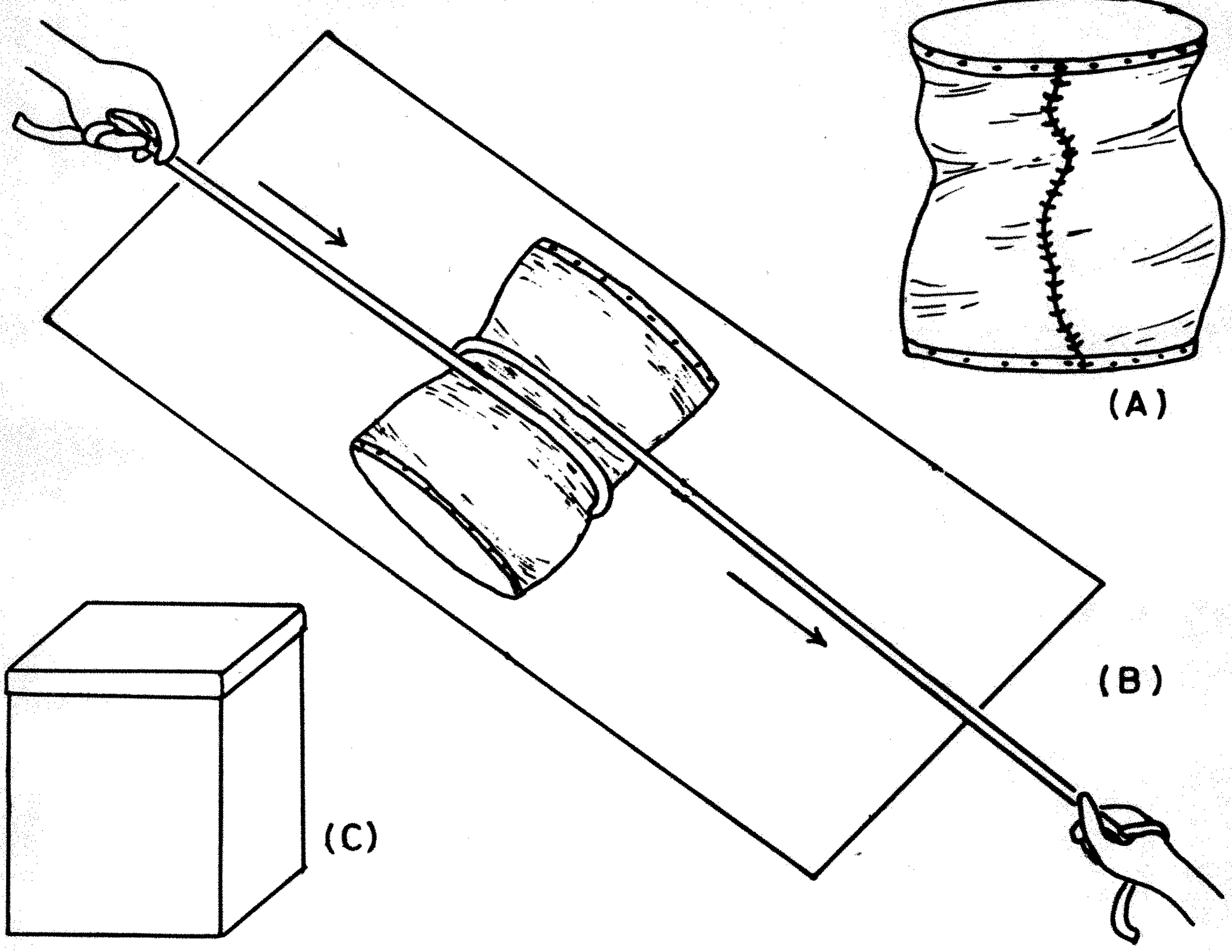

Fig. 10: Tumbling: (A) Leather tumbler; (B) Method of tumbling the leather bag; (C) Metal tumbling box

shaped beads rather than for polishing. Regular polishing was mainly carried out in a more efficient cylindrical leather bag (Fig. 10A).

Two circular wooden plates of about 30 cm diameter, placed about 40-50 cm apart were used to make the tumbler. The main body of the tumbling drum was, however, made of leather. After the beads, polishing powder and water were put into it both the sides of the leather drum were nailed to the wooden plates. Sometimes this bag was made entirely from leather without the wooden plates. This flexible tumbler was rolled to and fro by two men pulling a long rope that encircled the tumbler with a loop (Fig. 10B). This process of tumbling was carried out for 8-10 days to obtain a superfine polish.

Cutting Hollowed Objects

Objects like a mortar or cup were carved by a very interesting process. The outer portion was shaped by regular hammering and chiping, as explained earlier. Surprisingly though, for the inner portion a bow drill was first used to drill a series of closely spaced holes (Fig. 11A), and subsequently, using a chisel and hammer, the drilled portion was cut off to obtain a larger hollow portion (Fig. 11B). Once a sufficiently large part was cut out, it was enlarged further by chipping the remaining portion with a button head iron hammer.

Discussion and Conclusion

Elegantly shaped and beautifully polished stone beads from various archaeological sites reveal that the lapidary's art had reached a high degree of excellence as early as 5000 yr B.P. However, not much evidence has been obtained to illustrate how exactly the beads were cut, polished and perforated. When the unfinished beads and grinding hone from Chanhudaro are observed (Mackay 1937), the process of bead making in Harappan times does not seem to have been different from what it was at the beginning of the 20th

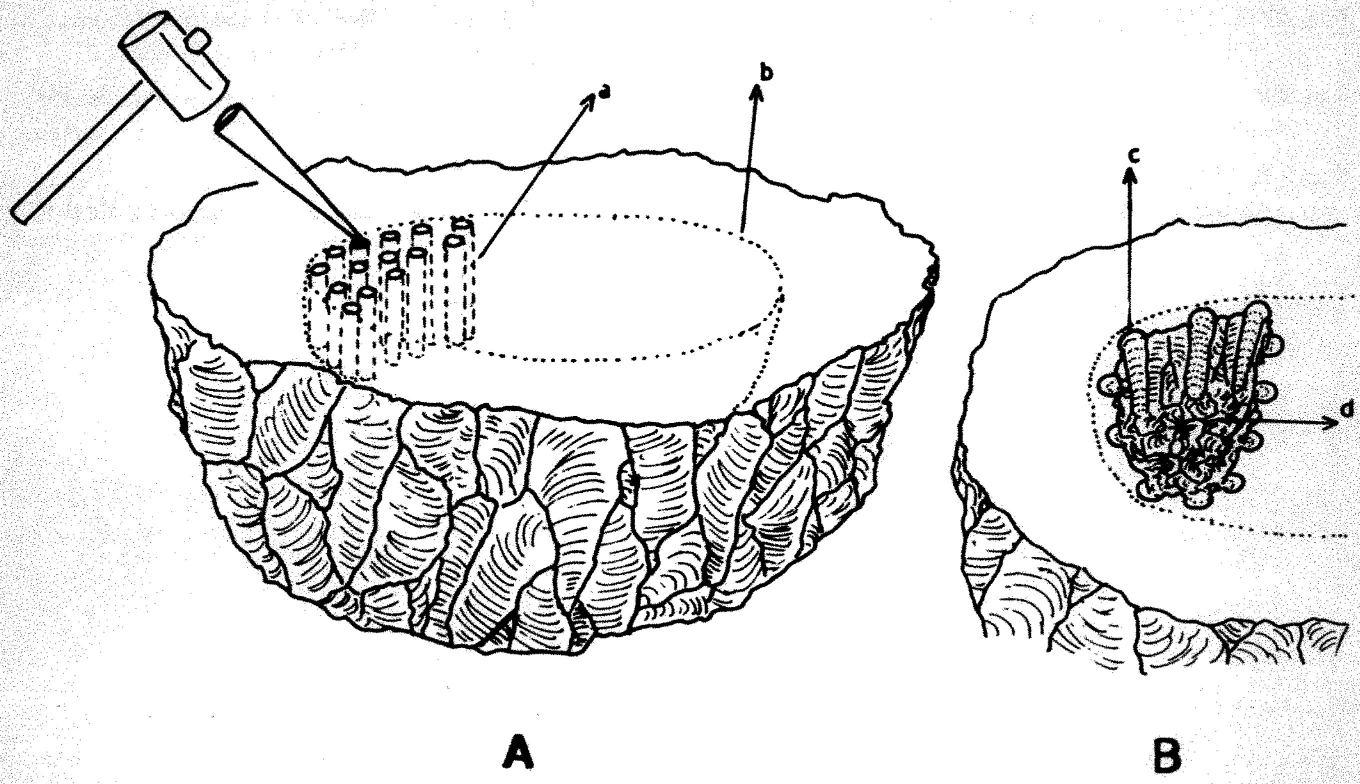

Fig. 11: Cutting the inner part of a mortar: (A) Chiselling the holes; (B) Cut off portion: a — closely spaced holes; b — portion intended to be cut; c — trace of cut hole; d — conchoidal fracture

century in Cambay. Rao's statement (1973: 103) "... Present-day bead makers follow the same process which the Harappan lapidaries had evolved", does not seem to be an exaggeration.

Nevertheless, it is essential to study the beads from various cultural levels to establish in greater detail how the various stages of bead making evolved through time.

Acknowledgements

The author is grateful to Mr. Mulchand M. Zaveri, Mr. Vinod M. Patel and Mr. Gunvantbhai C. Patel for providing valuable information.

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The Pre-Harappan Period at Prabhas Patan and the Pre-Harappan Phase in Gujarat

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Abstract

This paper discusses new data brought to light by recent excavations at Nagwada, Dholavira and Prabhas Pathan and re-examines the view that the earlier village communities of Gujarat are associated with the Mature/Urban phase of the Harappan in Gujarat.

Introduction

The state of Gujarat is one of the most intensively explored areas of India. There are approximately 450 sites that can be classed as a part of the Harappan Civilization in this region, many of which have been excavated (Possehl in press a, contains a list of the most important of these excavations). Until recently it was assumed that the earliest village based communities in Gujarat were associated with the Mature or Urban Phase of the Harappan Civilization (c. 2550-2000 B.C.). Recent excavations at the site of Nagwada in the estuary of the Rupen river in north Gujarat (Hegde *et al.* 1984-85; Hegde 1989) and the major Harappan site of Dholavira (Bisht 1989, 1991) on Khadir Island in Kachch have brought to light earlier material that would (Fig. 1) seem to indicate that this position is no longer tenable. The new data will be discussed below. Prabhas Patan (*IAR* 1971-72, 1975-76, 1976-77) excavated in the 1970s by Deccan College and the Gujarat State Department of Archaeology, also has early material, probably comparable in time to that from the early periods at Nagwada and Dholavira, adding a third place to the list of Pre-Harappan village settlements in Gujarat. The aim of this paper is to discuss these new data as well as to present further information on Prabhas Patan.

Prabhas Patan

The ancient mound of Prabhas Patan (20°45' N 70°29' E), also known as Somnath Patan or simply Somnath lies on the east bank of the Hiran (Hiranya) river just to the west of the modern town of Prabhas Patan, with its famous sea-side Siva temple (Fig. 2). The site was first excavated under the direction of the late P.P. Pandya in the 1950s (*IAR* 1955-56: 7-8, 1956-57: 16-17) and published by M.S. University and the Gujarat State Department of Archaeology (Nanavati *et al.* 1971).

The early work at the site was undertaken on a small scale. However, since the mound is obviously an important one, in the 1970s Deccan College and the Gujarat State Department of Archaeology developed a plan to renew excavation at the site[1]. This work was carried out by the senior author and Dr. Z.D. Ansari under the direction of the late Professor H.D. Sankalia.

The renewed excavations were conducted during three seasons (1972, 1975 and 1976) of intensive work. The site is large (c. 450 X 200 m or 9 hectares) with five mounds, each connected to the other. The surface is littered with broken stones; some of it carved. A Sun Temple of the 11th century A.D., still largely intact, stands on the most prominent part of the site, near the locality selected for renewed excavation.

Prabhas Patan has evidence for five periods of occupation, given as follows. The date for the Pre-Prabhas period is discussed below.

Period V	Kshatrapa-Gupta (c. 1st to 4th century A.D.)
Period IV	Early Historic (c. 4th century B.C. to 1st century A.D.)
Period III	Late Prabhas Culture (Lustrous Red Ware) (c. 1700-1400 B.C.)

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[1] The preparation of a report on these excavations is currently under way at Deccan College. This note is intended to be an interim document, simply highlighting the significance of the Pre-Prabhas material at the site. G. Possehl would like to note that the preparation of his portion of this paper has benefited from discussions with Dr. V. Shinde of Deccan College.

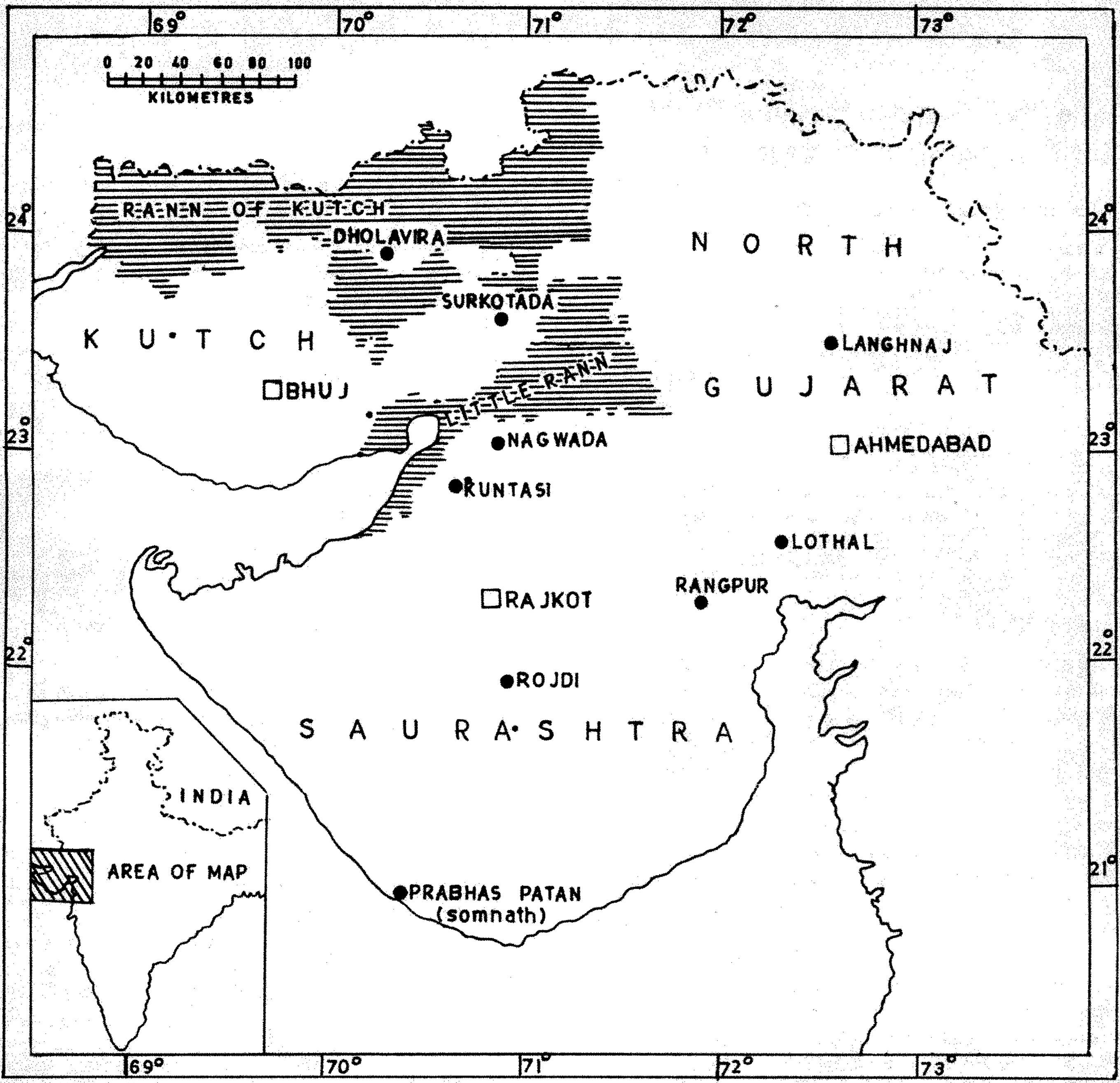

Fig. 1: Map showing excavated Harappan sites in Saurashtra

Period II	Early Prabhas Culture (c. 2200-1700 B.C.)
Period I	Pre-Prabhas Culture (c. 3000-2800 B.C.)

The lowest, Pre-Prabhas levels of this site were found towards the end of the first season of work. They cover c. 75 sq m in trenches A5, B5, C6 and are associated with strata 14, 15 and 16. Stratum 15 was also recorded in trench D6. These strata rest on a sterile deposit of marine sand (Fig. 3). The material from the cultural levels consists of pottery, a few chalcedony blades, beads of faience and steatite, some of which are segmented. Most of the antiquities came from stratum 15, along with a fragment of wall plaster with reed impressions, suggesting simple "wattle and daub" architecture.

Pottery

The Pre-Prabhas culture is characterized by four ceramic wares:

1. Red ware 2. Incised Red ware 3. Black-and-Red ware 4. Grey ware

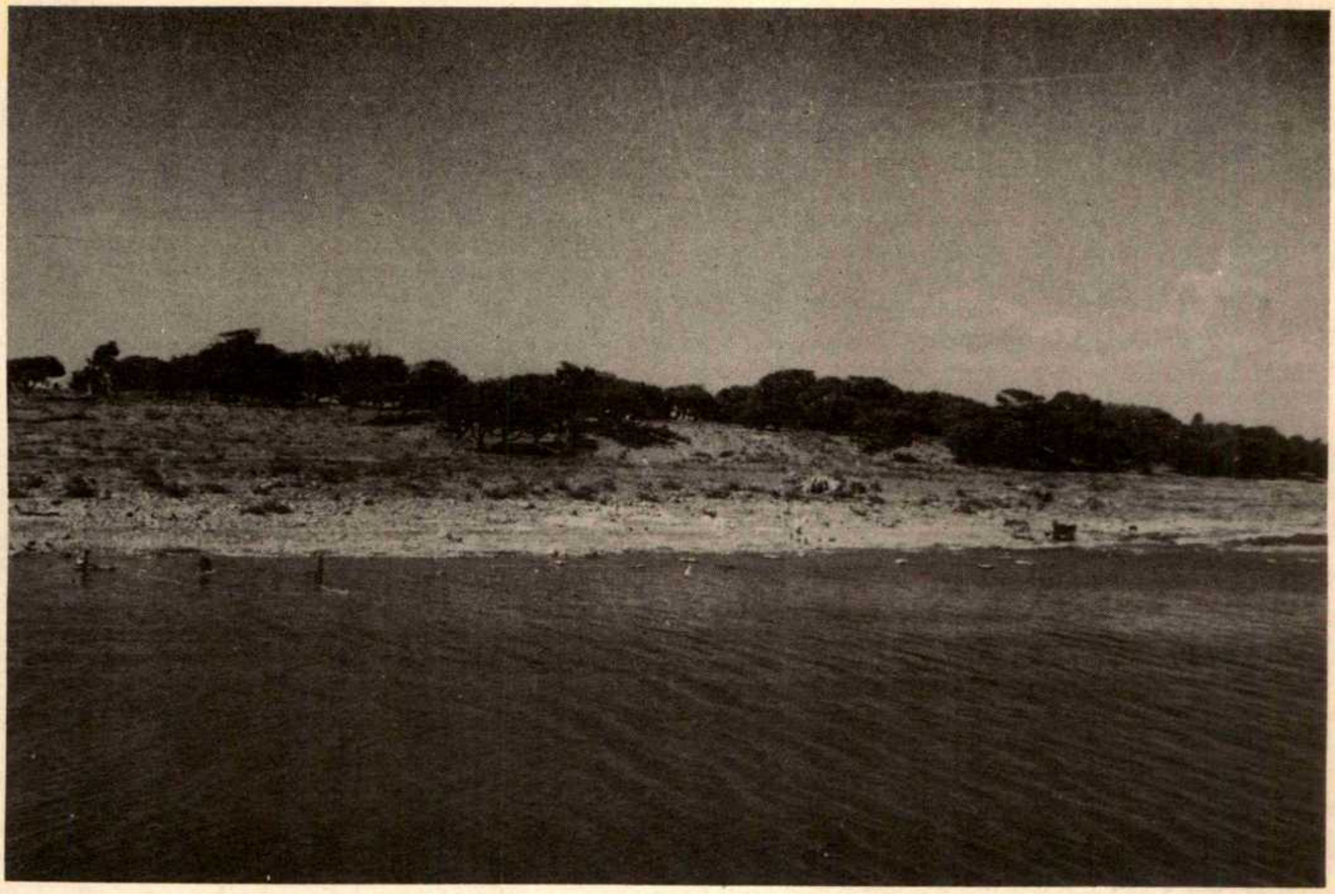

Fig. 2: Ancient site at Prabhas Patan

Red Ware (Fig. 4): This Red ware is hand-made and has a smooth surface; the fabric, however, is coarse. The forms represented are mostly wide-mouthed jars (T2-T7) and very rarely a dish.

Incised Red Ware (Fig. 4): This ceramic is also crude and coarse in fabric; it is not treated with any slip and the surface varies from drab red to grey. The incised designs, which mostly consist of bold strokes, were probably executed by a rather blunt instrument (T8, D1-D7). The shapes include mostly basins, either deep (T8) or shallow (T9).

Black-and-Red Ware (Fig. 5): The Black-and-Red ware is perhaps the most interesting ceramic on account of its fabric and surface treatment. There are only a few sherds of this ware but these are quite distinctive. Since the rim sherds are extremely rare it is difficult to form a clear idea of the shapes represented in this ware. It is highly likely that the vessels were completely black on the interior and fully red on the exterior. The fabric, as compared to that of the other wares, is fine and the surface is treated with a red or orange slip. The exterior is highly burnished and has incipient horizontal or oblique ribs (D2-D6). The internal surface is also quite smooth.

The few forms which can be made out include wide-mouthed jars (Fig. 5: T1, T3, T5 and T6) and a small carinated *handy* (T4). Some of the vessels have ringed bases (Fig. 5: T2).

Grey Ware: The Grey ware is quite crude and is modelled by hand. This ceramic does not have a consistently greyish surface and we also come across vessels which are drab red in colour. This obviously is the effect of peculiar conditions of firing. The shapes include dishes (Fig. 5: T7) and wide-mouthed jars (Fig. 5: T9, T10 and T12). There are a couple of specimens of jars with smaller mouths (Fig. 5: T8 and T11). Some of the vessels have flat bases (Fig. 5: T13, T14 and T15).

There is some evidence for floods during Pre-Prabhas times with the presence of a yellowish silt in stratum 15. It is possible that the area in which the excavation took place is a secondary deposit resulting from this flood and that the original habitation is elsewhere under the mound. There is an hiatus between the Pre-Prabhas and the Early Prabhas levels. Two radiocarbon dates for Pre-Prabhas Somnath are given in Table 1[2].

Table 1. Prabhas Patan, Period I Pre-Prabhas occupation

	Date b.p. 5568 Half-life	**Date b.c. 5730 Half life**	**Calibrated date B.C. date B.C. (Calib Programme)**
PRL-90	4240+110 b.p.	2415+115 b.c.	2892 cal. B.C.
Trench B5, stratum 15, charcoal			
TF-1287	4280+105 b.p.	2460+110 b.c.	2911 cal. B.C.
Trench D6, stratum 16, shell			

(Agrawal and Kusumgar 1973; Agrawal *et al*. 1976).

The Date of the Pre-Prabhas Settlement

The two early dates from Pre-Prabhas levels have been a source of some debate and discussion. In general, opinion has favoured the view that they are too early and that the Pre-Prabhas Culture should be dated to c. 2000-1800 b.c. (Dhavalikar 1984) which would be c. 2450-2150 B.C. on the calibrated radiocarbon time-scale being used here. This late chronology accommodates the presence of the pottery thought to be of Harappan affiliation, a few sherds of which were found with the Pre-Prabhas wares[3].

The two dates, however, are very consistent with one another. They were run at different laboratories, but with the same team managing the dating procedures. The fact that one comes from charcoal (PRL-90) and the other from shell (TF-1287) should also be noted, because in some ways this enhances the credibility of the consistency between them. These points are sound reasons for the dates to be accepted and for the Pre-Prabhas ceramics, other than those said to be "Harappan-like", to be recognized as unique. Moreover, there are now other sites in Gujarat that have evidence for settled life at a period contemporary with the revised chronology for the Pre-Prabhas community.

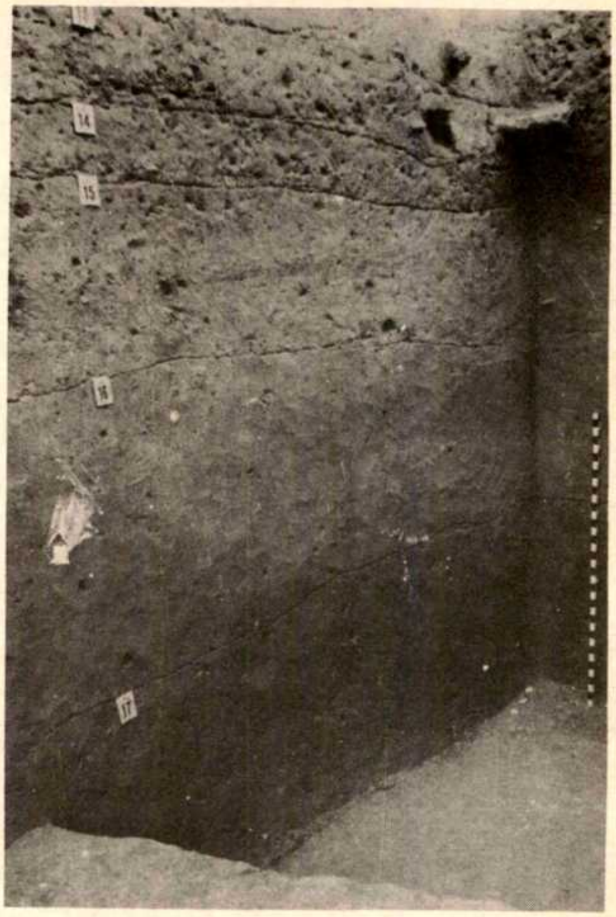

Fig. 3: Section at Prabhas Patan showing the sterile deposit of marine sand, Layer 16 and 17

Other Early Village Farming Communities in Gujarat

Recent excavations at Nagwada (Hegde 1990) in the estuary of the Rupen river in north Gujarat and Dholavira on the island of Khadir in the Great Rann of Kachchh (Bisht 1989, 1991) have produced material which can, in all likelihood, be associated with the first half of the third millennium B.C. (c. 3000-2500 B.C.). These settlements precede the beginnings of the Urban Phase Harappan at c. 2550 (Possehl in press b) and are at least partially contemporary with the Pre-Prabhas settlement just discussed.

Nagwada

At Nagwada the evidence for these early settlers comes in the form of a burial, actually a cenotaph, that contains

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[2] Dates in Tables appear in three forms: 1) the date computed on the older, inaccurate "Libby half-life" of radiocarbon at 5568 years. The use of this older half-life is the one retained in the official reports given in the journal *Radiocarbon*. As per their convention this date is given in years "before present" or "bp" which is by convention taken to be before 1950 A.D.; 2) the date given by the most accurate half-life of radiocarbon at 5730 years, but as a "bc" (before Christ) or "bce" (before common era) date, with 1950 years subtracted and rounded to the nearest five years; 3) all radiocarbon determinations have been calibrated using the "Calib" computer programme from Professor M. Struvier of the Quaternary Isotope Laboratory at the University of Washington, Seattle. The calibrated dates used in this paper are based on the calibration curves he has developed in conjunction with his colleagues. In citing radiocarbon dates we have followed the international convention of using lower-case letters for uncalibrated measurements, as b.c. or b.p. and upper case letters preceded by "cal" for measurements, calibrated into "real" dates in calendar years, as B.C. or A.D.

Dates in the text with "B.C.", "B.P." or "A.D." in upper case should be taken to mean that the date is intended to be in real, calendar years, not uncalibrated radiocarbon years. Dates given as "b.c.", "b.p." or "a.d." in lower case should be taken to mean that the date is given in uncalibrated radiocarbon years, using the more accurate 5730 half-life for radiocarbon.

[3] There was some thought that these two dates could have been contaminated by the miliolite limestone that is in the Somnath region. This is a form of calcium carbonate and would routinely found have been removed through pretreatment of the charcoal using hydrochloric acid.

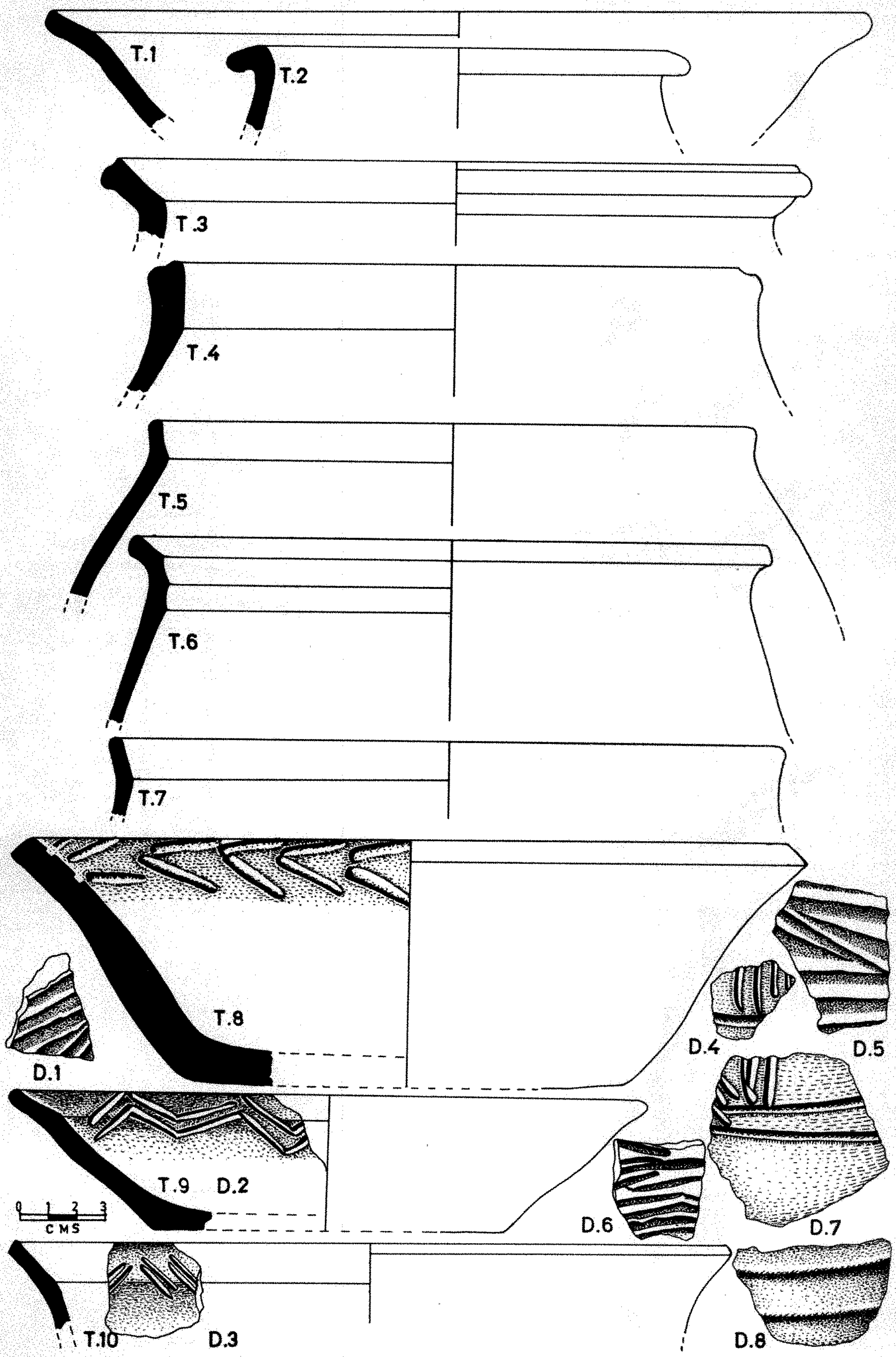

Fig. 4: Red ware: T1-T7; Incised Red ware: T8-T9, D1-D8

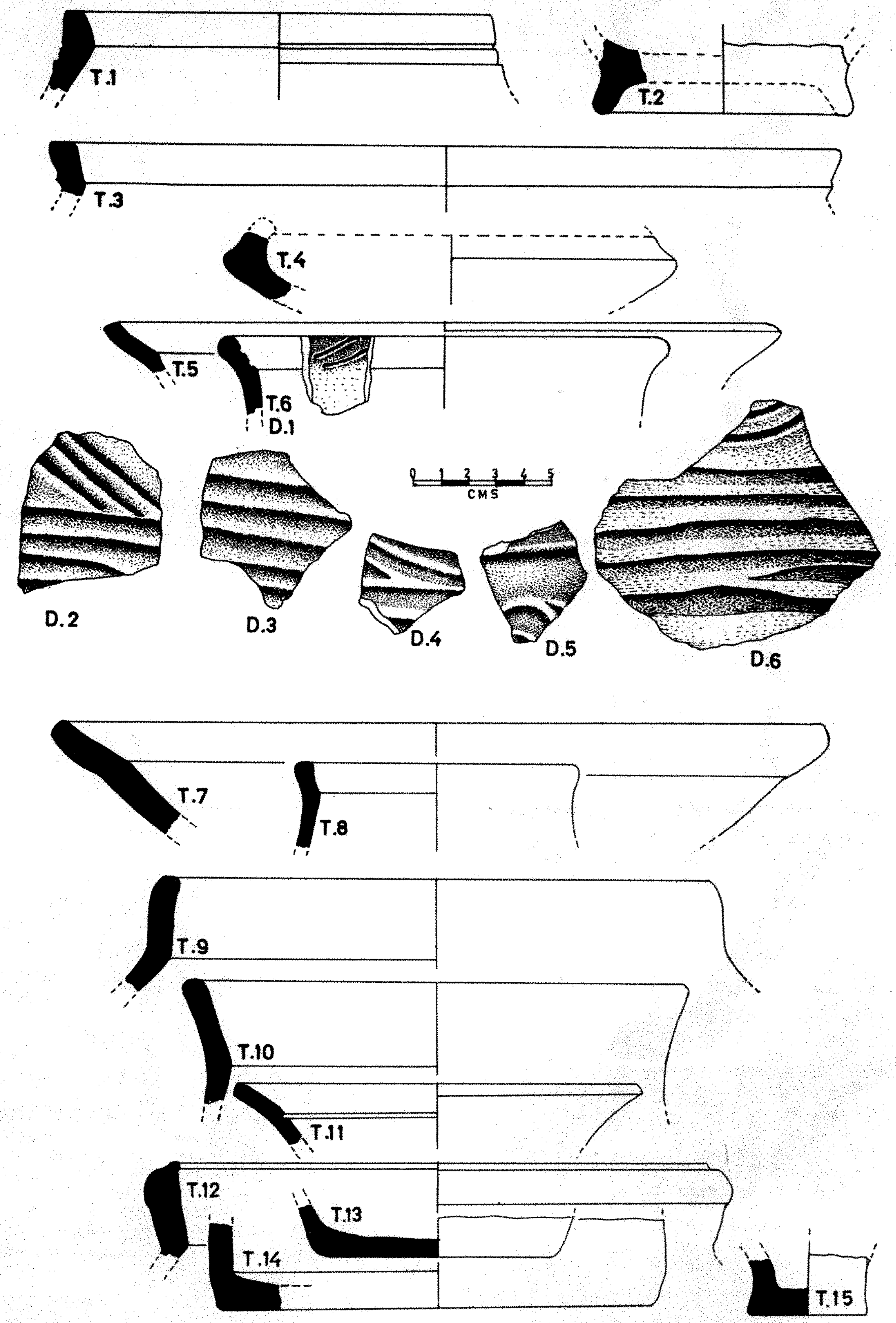

Fig. 5: Black and Red ware: T1-T6, D1-D6; Grey ware: T7-T15

ceramics which are distinctly like those from the first period at Amri in the lower Indus Valley of Sind (Casal 1964). They are fine pink to red wares, with the high featureless rims characteristic of this period (Hegde 1989). While there are no radiocarbon dates available for the Nagwada cenotaph, the formal stylistic characteristics of the pottery are quite convincing and we can comfortably assign this material to the general time period between 3000 and 2600 B.C., at least for the moment. The Nagwada cenotaph, with the Amri pottery, is then a part of the larger Harappan Cultural Tradition (Possehl 1977) and assigning it to the Early Harappan, as defined by Mughal (1970), is quite appropriate.

This early appearance of Indus related material in north Gujarat has been questioned because there is no trail of Amrian sites leading from the Indus Valley to this area. While there are Urban Phase Harappan sites in southeastern Sind (Lambrick 1946; Khan 1979) no Amri sites have been found to date. But the Amri connection in the Nagwada pottery is strong, and some suggestions concerning the mechanism that brought it to Gujarat are called for. We want to emphasize that our thoughts on this matter are intended to stimulate research on this topic. We are not offering an answer to this question so much as suggesting a reasonable hypothesis which can be tested through archaeological exploration and excavation.

A Mechanism for the Expansion of the Amrian Peoples into Gujarat

Studies on the environment in Gujarat during the premodern era are meager, but it is agreed, we believe, that during the third millennium north Gujarat was an open sandy savanna, with abundant grasslands. Saurashtra was more forested, but with small acacias and tamarisks, and also graced with abundant pasture lands. The aboriginal population in these two regions seems to have been made up of various small, scattered, hunting and gathering peoples. The abundant pasture available in Gujarat would have been an attractive resource for Harappans, with their substantial herds of cattle even as early as the Early Harappan Phase (3000-2500 B.C.), if not before. We propose that Early Harappan herders in Thar Parkar of southeastern Sind gradually explored regions to the east and south, moving around the northern edge of the Ranns of Kachch, possibly even directly across them in the dry season, in their search for pasture. They may have even known these regions well, from earlier exploratory journeys, hunting and searching for raw materials, and that the pastoral encroachment followed these temporary "expeditions" as a form of longer term exploitation. This pastoral occupation may have been seasonal in nature, at least for some of the herders, who moved back and forth from the Indus Valley to these pastures, joining and then parting from others of their kind who found it advantageous to remain in the new grasslands. Once again, the date for these "incursions" is not known, but it seems to have been several centuries prior to the emergence of the ancient cities of the Indus at c. 2550 B.C. It is roughly at this point in time that the village farming community comes to the ascendancy in Gujarat, and the very striking, well-defined Sorath Harappan appears (Possehl and Raval 1990).

Dholavira

Another site with an occupation preceding the Urban Phase Harappan has been found at Dholavira in Kachch. R.S. Bisht, the excavator of the site, calls it "pre-Harappan" (1991: 76). Deep digging in the rain gully in the southwestern quadrant of Dholavira revealed over 12 m of stratified habitation remains, including these pre-Harappan deposits, which underlie a reasonably typical Mature or Urban Harappan. "The first occupation of the site… pertains to a non-Harappan or pre-Harappan culture represented by an accumulation of 60 to 70 cm that lies over sterile strata made up of disintegrated rock loosely knitted with sand, which may be an artificially raised deposit" (Bisht 1991: 76).

The ceramics of Period I at this site have been described in only a preliminary way, but include wheel-made, red to pink wares. Comb incised wares, as well as a "reserved slip" ware have been reported. Little has been said of forms, but deep dishes and jars have been reported. Slips are present in red and darker tones. Painting, also in dark colours, sometimes highlighted with white, is present as well. It should be recalled that painting in white is one of the hallmarks of the Early Harappan, occurring in the Amri/Nal, Kot Diji and Sothi Complexes, as well as in the Quetta Valley in Damb Sadaat I and II times.

Minor antiquities are rare in Period I but Bisht notes that copper tools and other implements are found "... in good strength" (1991: 76). Overall, it is the opinion of the excavator that: "The Indus elements in pottery as well as antiquities are conspicuous by their absence" (Bisht 1991: 76).

While there are no radiocarbon dates from Dholavira the presence of this material, stratigraphically below the Mature, Urban Phase Harappan should place it within the first half of the third millennium, comparable in time to the Nagwada cenotaph and Pre-Prabhas Somnath.

Lothal and the Micaceous Red Ware

Finally we want to note that the lowest levels of Lothal produced a body of ceramics generally called Micaceous Red ware, that have been thought to indicate a Pre-Harappan occupation in the vicinity of this site (Sankalia 1987: 40-41). In spite of an exhaustive search, S.R. Rao never found Micaceous Red ware in an isolated, self-contained context, free from associated Harappan Red wares. In fact, the 1961-62 season of work at the site was largely devoted to documenting such a context (*IAR* 1961-62: 9-10). Still, Micaceous Red ware is not a part of the Harappan ceramic inventory and can in that sense be considered "foreign" to it.

The unresolved question is: does this ceramic indicate the presence of non-Harappan, pottery-using peoples in the vicinity of Lothal prior to its settlement early in the Urban Phase; or is the Micaceous Red ware a local innovation of the Harappan potters at the site? Resolving this issue remains one of the important problems for regional archaeology in Gujarat.

Concluding Remarks

None of the three sites under primary consideration in this discussion offers sufficient evidence for conclusions to be drawn as regards the early history of Gujarat and its relationship with ancient Sind. But, there seems to be an emerging picture that village farming communities were being established in Kachch, Saurashtra and north Gujarat well before the emergence of the Mature Harappan at c. 2550 B.C. and that the older notion of a migration into this region at this time may no longer be a proposition that is supported by archaeological data.

It is apparent that there is considerable cultural diversity in the early levels at these three sites. To illustrate: Nagwada seems to be directly a part of the "Amri/Nal Complex", while the Pre-Prabhas material is quite different from this, and what we know of Dholavira I. If we choose to consider the Micaceous Red ware of Lothal this would be a fourth cultural historical context. Thus, there may be as many as four strands of cultural historical material documented in Pre-Harappan Gujarat, each with its own origins, each more-or-less independent of the others, that are involved in the unfolding story being suggested here.

Finally, there is a clear need for other sites of this time range to be located and excavated. The Pre-Prabhas levels at Somnath are found under c 6 m of later material. Therefore, this is not the site at which a full excavation of this important phase of history can efficiently be investigated. Surely, there are other sites in Saurashtra with this material, and they should be found and excavated. Further excavations in the Rupen Valley should be pursued, with the aim of finding habitation levels assignable to the time period of the Nagwada cenotaph. It is abundantly clear that in spite of the fact that a great deal of archaeological research has been undertaken on the Harappans in Gujarat, there is still much to be learned.

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Excavations at Padri — 1990-91: A Preliminary Report

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Abstract

This is the preliminary report of the excavation at Padri, Bhavnagar District, Gujarat, carried out during February-March 1991. It revealed a twofold cultural sequence, the Early Historical (c. 1st century A.D.) and Harappan (c. 2200-2000 B.C.) separated by a thick sterile layer suggesting a break in the occupation. This paper highlights some of the new features of the Harappan civilization in Saurashtra, like rectangular mud structures, evidence for a horned deity and a new ceramic named "Padri ware", brought to light from this excavation.

Introduction

The village of Padri Gohilni (22°22' N: 72°95' E), taluka Talaja, Bhavnagar District, lies hardly 2 km away from the Gulf of Cambay. It is roughly 8 km to the west of Talaja and 50 km to the south of Bhavnagar town (Fig. 1).

The ancient site at Padri, locally known as *kerala ne dhoro*, is roughly 2.5 km south of the present village. It is nearly 2 km away from the Gulf of Cambay, but its southern edge is affected by tidal fluctuations. The site is located in a shallow depression on a slightly elevated sand dune. However, the ancient site was probably protected from the destructive impact of tidal waves by a natural barrier of basalt rock, roughly 6 m high, and running parallel to the sea coast. There is no source of potable water within a radius of 1.5 km of the site. On the northern side of the site there is a vast tract of fertile land, which currently supports crops such as bananas, groundnuts and wheat. This is possible only because of artificial irrigation facilities. This area is part of the semi-arid zone characterised by hot and humid summers. The annual precipitation ranges from 400 to 800 mm.

In spite of the the site being close to the coast, it does not appear to have played an important role in the overseas trade of the Harappans. This assumption is based on the fact that the site was not situated directly on the coast, and a detailed survey of the mound and the surrounding area has not yielded any evidence indicating that the site was a port. On the other hand, the settlement could have been situated at least 3-4 km inland had the main intention of the occupants been cultivation. In all probability therefore, the site appears to be have been a processing centre where salt was made and then supplied to the other settlements. Even today many families from Padri and the nearby villages are engaged in the manufacture of salt. Many of them have even established permanent dwelling structures close to their working place. The discovery of three unusually large jars and a high percentage of the sherds of similar ones in the ceramic assemblage, is significant. All the potsherds scattered on the surface as well as those found in the excavation belong to a fine, painted ware, made from very well-levigated clay and fired uniformly to a high temperature. These jars could have been made exclusively to store and transport salt to different places, as suggested by their superior quality and sturdiness, making them capable of withstanding the vibrations created in the process of transportation. Jars that were so painstakingly manufactured would not have been used merely for the storage of grain, since vessels of a coarser variety or pit silos would have served the purpose. However, the soil samples collected from the pots and habitational layers need to be subjected to chemical analysis in order to check the validity of this hypothesis.

The ancient site at Padri spreads over an area of 340 m (E-W) X 210 m (N-S). The excavation revealed a two-fold cultural sequence, namely the Early Historic (1st century B.C.-A.D.) and Harappan (c. 2200-2000 B.C.). The total habitational deposit is 3.2 m thick of which the upper 1.2 m belongs to the Early Historic period. There is a 0.60 m thick black sterile layer between the two cultural periods, suggesting a break in the habitation. The formation of this sterile layer took place after the desertion of the site around 2000

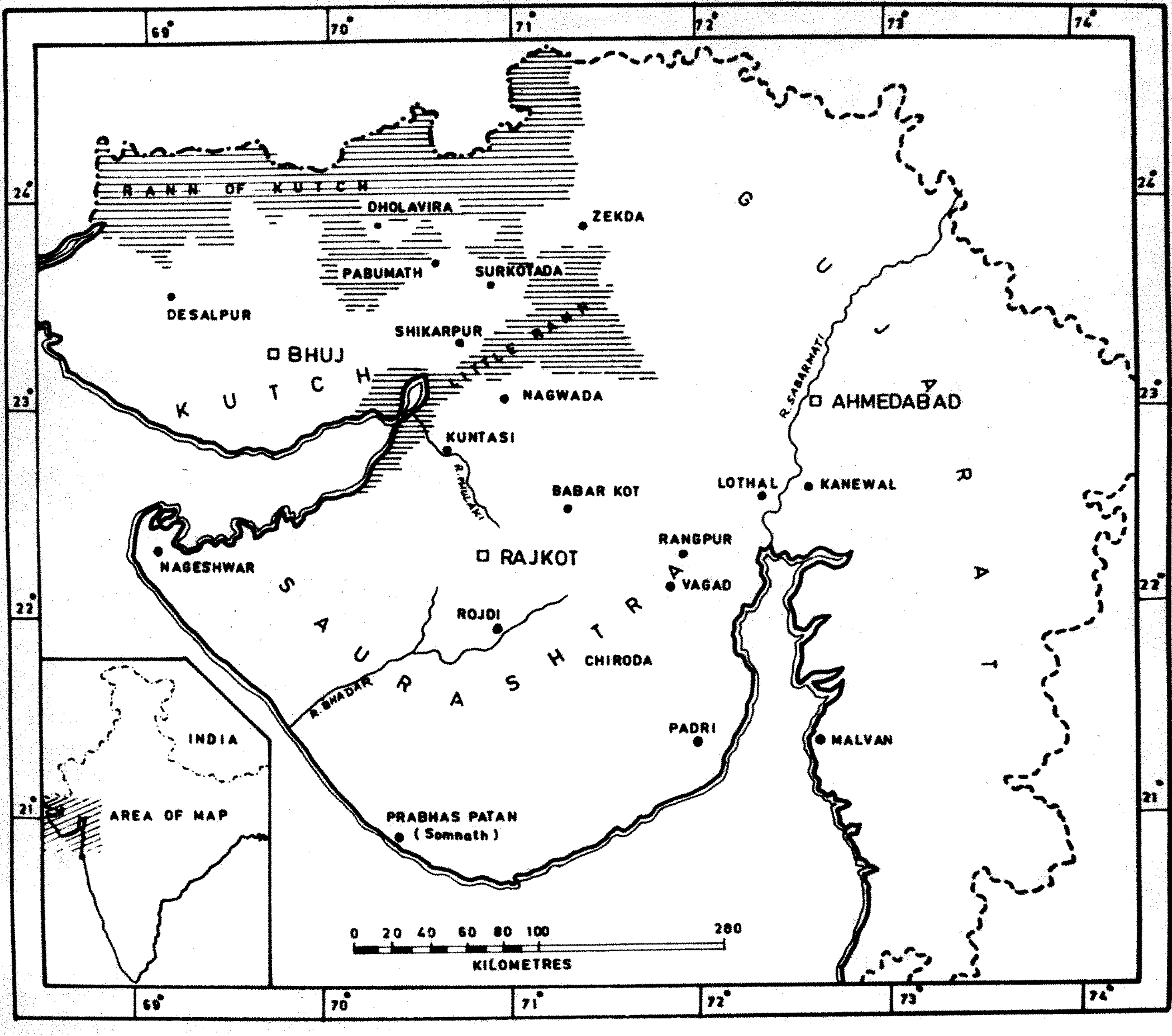

Fig. 1: Map showing the location of Padri and some other excavated sites in Gujarat

B.C. and prior to its re-occupation in the 1st century B.C., a gap of nearly 1900 years. In spite of the fact that the site was never re-occupied after the 1st century A.D., a similar sterile layer did not form for a period of nearly 2000 years. It is yet to be understood what factors were responsible for the formation of such sterile layers.

Relentless digging by the villagers both from Padri as well as nearby villages has caused considerable damage to the site and nearly one third of the habitational mound, particularly the western and northwestern parts, have been dug up. In fact it is sad to note that the villagers still use the habitational soil to mould bricks for construction purposes.

Two trenches, one (C3) near the southern slope of the mound and the other (J2) almost in the central part of the mound were selected for excavation. The selection of two different localities within the site was intentional. J2 was dug to ascertain the total thickness of the habitational debris and the cultural and the ceramic sequence at the site, whereas C3 and the other adjoining trenches will be extended towards the periphery with a view to finding out the nature of settlement. The main aims for undertaking this excavation was to study the cultural process, temporal and spatial change, as well as the distribution pattern of the Harappan ceramic assemblage. With this in mind, a new recording method, described as a "lot system", was introduced. Every dig, not more than 0.10 m deep, was recorded as a separate lot number. A 5 m X 5 m trench was divided into four quadrants and each one was dug separately as per the lot system.

Period I — Early Historic

This period is represented by Red Polished ware which is

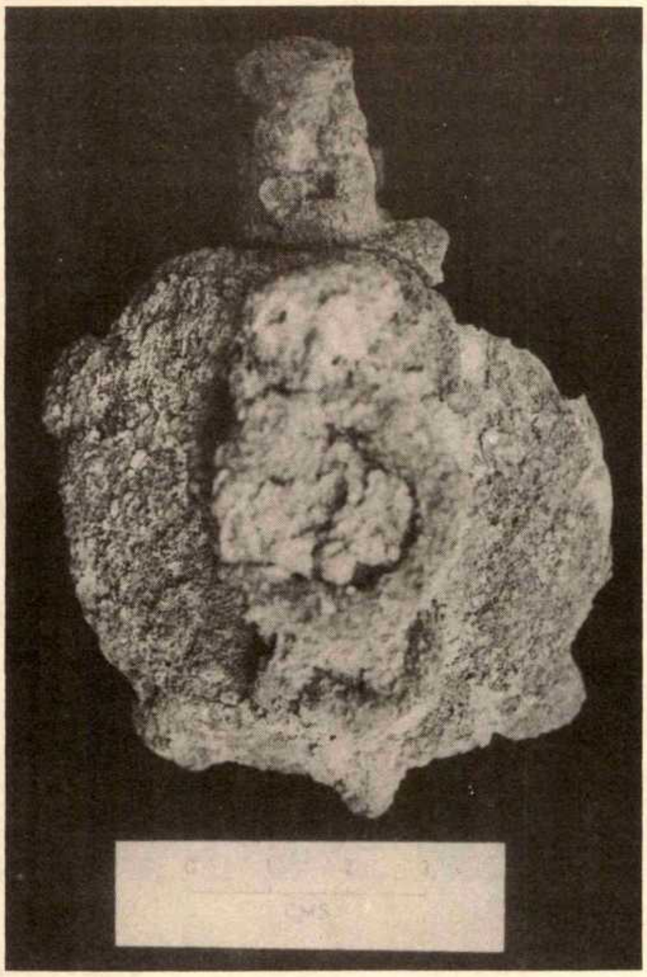

Fig. 2: Tortoise-shaped copper lamp, Period I

made of coarse clay tempered by sand and chopped grass. This ware is mostly wheel-thrown and is treated with a thick red slip. The black core suggests poor firing conditions. The most common shapes are cups with tapering sides and flat bases, globular jars with out-curved rims, lids, deep dishes, etc. The period can be dated to the 1st century B.C.-A.D. on the basis of evidence such as a clay tablet bearing the Brahmi script and a copper coin similar to that of the Kshatrapa king, Nahapan. Because of abrasion, the legend on the clay tablet is not clear. Similarly, encrustation formed on both sides of the copper coin makes identification of symbols on it, if any, difficult. No structural remains were noticed in the excavated trenches, but a few structures of burnt brick are visible on the surface, particularly on the southeastern side. Among the finds, mention should be made of a tortoise-shaped copper lamp (Fig. 2), and the upper half of a moulded terracotta human figurine. The copper lamp has a channel to accommodate a wick and four projections on four sides, possibly for tying it with a thread to suspend it. The evidence of two boat-shaped terracotta objects (Fig. 3), made from very fine clay and treated with red slip, deserve mention here. Both bear two perforations on the projected central portion, resembling a mast, and have three grooves on the underside of one and two on the other. The exact function of these grooves is hard to imagine, but since they are aligned parallel to the perforations it would not be far-fetched to surmise that they were associated with weaving activities. The upper two layers, representing the Early Historical level, are slightly loose in texture and are brownish in colour and thus they can be easily distinguished from the Harappan strata.

A human skeleton was found at the top of layer 2 in the southwest quadrant of trench C3 (Fig. 4). The skeleton certainly belongs to the Early Historical period, as the stratigraphical position and the material goods associated with it suggest. The skeletal remains were found to be lying in an extremely awkward position on the ground and were not buried intentionally in a pit. The right leg of the skeleton was bent and turned towards the west, whereas the left one was brought straight forward towards the east. The skeleton faced east, with its head bent down and its chin almost touching the chest. The right hand was taken back towards the north with its hand bent backwards. The left hand was below the head and bent towards the east with its forearm twisted inwards. The lower jaw, upper part of the skull and a part of the left humerus were partially destroyed in the process of excavation. The position suggests that the person may have died an unnatural death.

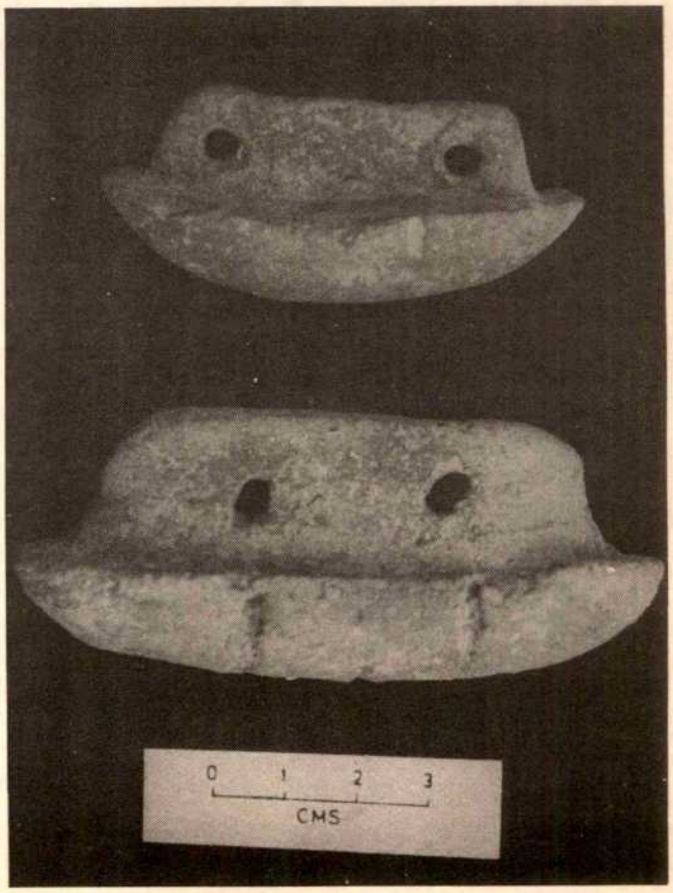

Fig. 3: Two boat-shaped terracotta objects, Period I

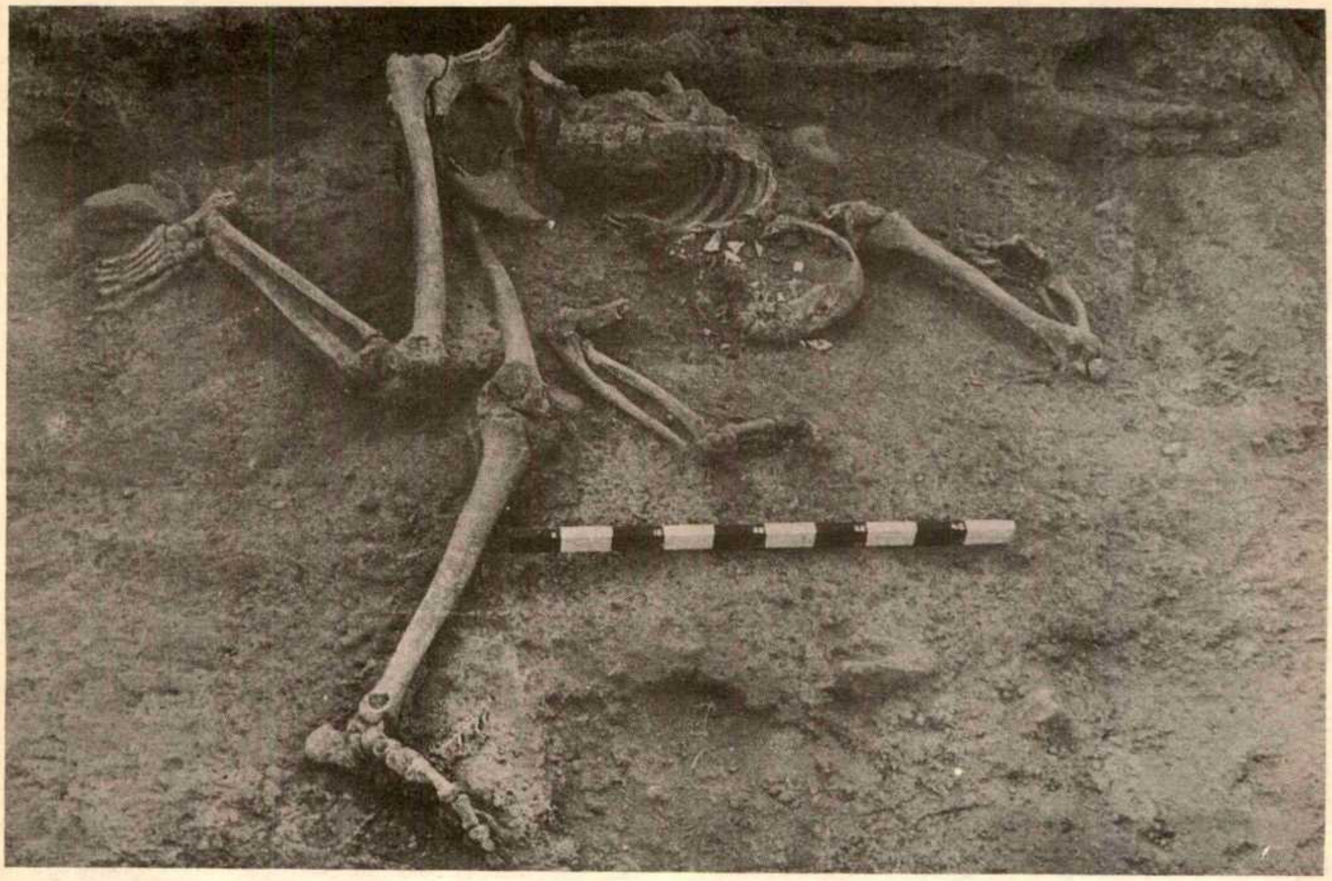

Fig. 4: Human skeleton, Period I

Period II — Harappan

The Harappan level (layers 4 to 10), as compared with the Early Historic, is compact in texture, dark grayish in colour and undisturbed. On the basis of the ceramic assemblage, the Harappan phase can be dated to c. 2200-2000 B.C., which is comparable to Rojdi B. The other characteristic Harappan objects such as long tubular carnelian beads, seals and sealings, weights and the Harappan script are conspicuous by their absence. This is not surprising as their occurrence in most of the rural Harappan sites in Saurashtra is sporadic. The Harappan settlement at Padri appears to be rural in character like that at Rojdi and Kuntasi, and, therefore as far as the settlement pattern is concerned, it is different from the large settlements such as Mohenjo-daro, Harappa, Kalibangan, Dholavira and Lothal. A town plan characterised by a citadel area and a lower town is also conspicuously absent. This site, unlike Kuntasi or Rojdi, does not seem to be fortified. Similarly, careful observations in disturbed areas and along sections, have not revealed any trace of the use of either stone or brick for construction.

Ceramic Study

The Harappan ceramic industry at Padri is similar to that of Rojdi B and can be divided into two broad categories, the fine and coarse wares. The former includes the Sturdy Red ware and Buff ware. Both these were made on a fast wheel as the uniform striation marks and even thickness of the pots would indicate. These wares were made from very fine levigated clay and a considerable amount of fine marine sand was added as tempering material. According to the present day potter in the nearby village of Tarasara, sand, as a tempering material, was necessary to achieve high and uniform firing temperatures. Both these wares can be subdivided into a thin and thick variety. The thick variety is mostly represented by large globular storage jars with either beaded or clubbed rims and small flat bases, cylindrical perforated jars, large shallow dishes with incurved sides and beveled rims and a few step-sided dishes with hollow flared stands. The thin variety includes types like convex-sided bowls with either featureless or slightly everted rims, goblets with flat bases, small basins, dishes and globular pots.

The Sturdy Red ware was treated with a thick red slip, which was mostly confined to the outer surface, but the wide mouthed pots and dishes bore a slip on both sides. The uniform firing to a high temperature turned the core brick red. The painted designs in black pigment on the upper half of the outer surface, include geometric patterns such as vertical and horizontal bands, hatched diamonds and loops. The animal or bird motifs on Harappan pots, reported from other sites, are very rare at Padri. It is generally believed that Harappan pottery is profusely painted but this does not hold

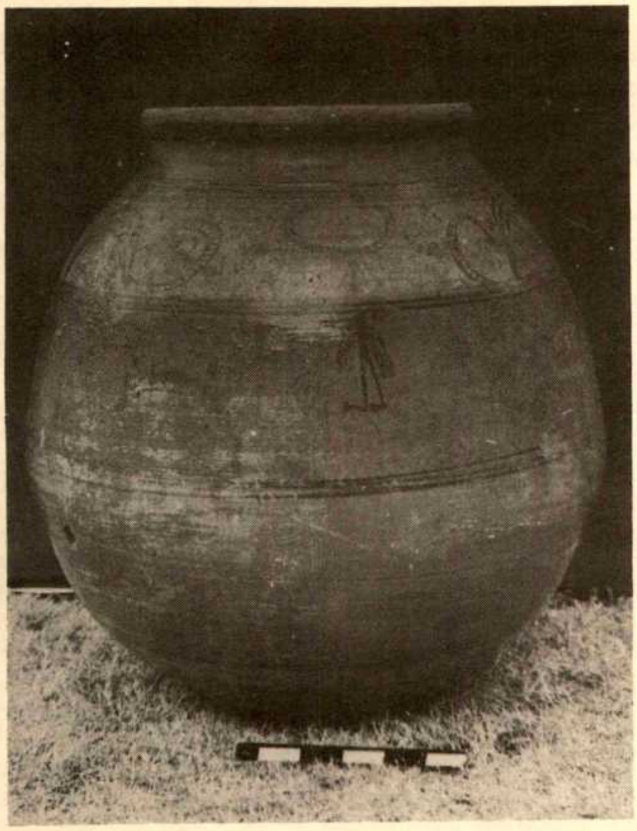

Fig. 5: Jar with buff coloured panel and a linear human figure

good in the case of Padri. The most common forms in this ware at Padri are convex-sided bowls with or without stud handles, dish-on-stand, small and large globular vessels, with either beaded, thickened out or clubbed rims. Most of the large globular jars have small flat bases.

Two unique jars among the thicker variety deserve special mention. These jars were dug out by the villagers, but with their help, we were later able to locate the exact find spots. Both these jars are globular in shape with beaded rims and have small flat bases. Of the two jars, the largest one, the only one of its kind found so far, is 0.81 m high and has a circumference of 2.34 m. It is not just the size of the pot which is unusual, the painted design executed on its outer surface is also significant. The painted design includes a buff-coloured panel bordered by a double horizontal band which incorporates a linear human figure with a horned headgear (Fig. 5). This figure is flanked by two pairs of curved lines on the right and three pairs on the left. They emanate from the group of three vertical wavy lines at the base of the motifs where two sets of curved lines join. The design which is represented by curved lines, ends with hatched curves, the tips of which bear three short strokes attached to solid circles. The horizontal loop-like curved lines most probably represent leaves and the vertical wavy lines signify the roots of some plant. The human figure is shown as if moving, with its right leg and hand brought forward. The large curved horns are hatched (Fig. 6) (Shinde 1991a). A similar figure, but in a seated posture, depicted on one of the Harappan seals at Mohenjo-daro has been identified as a prototype of the Hindu god *siva* (Mackay 1938, Pl. XCIV, 420), hence the significance of this jar.

The second jar found in trench MX2, is slightly smaller in size but identical in shape though not elaborately decorated. It bears a panel of buff colour on the shoulder which is bordered by a double horizontal band. The neck, waist and base of the vessel are decorated by a double, horizontal band of black pigment.

The Buff ware is similar to the Sturdy Red ware as far as the use of raw material, potting and firing techniques, the repertoire of painted decorations and forms are concerned. The pots of this ware were first treated with a buff wash over which was applied a light orange slip. Only three types, a convex sided bowl, a dish with or without stand and globular vessels of different sizes are represented in this ware.

One complete storage jar recovered from trench OX3 is 0.72 m high and has a circumference of 1.86 m. The upper

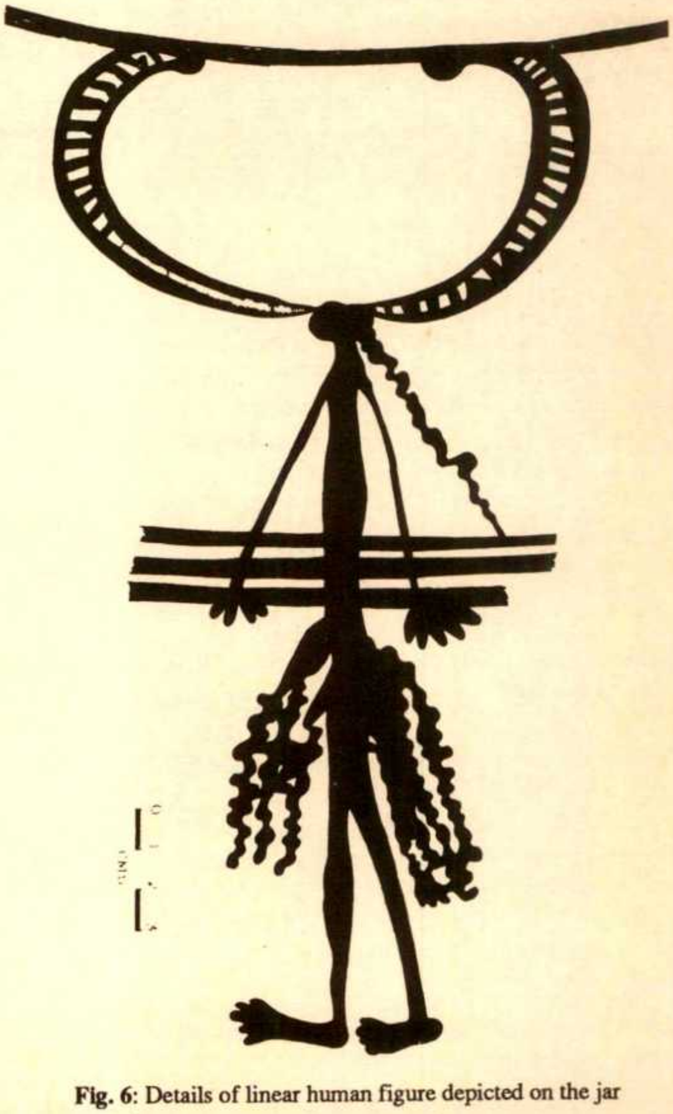

Fig. 6: Details of linear human figure depicted on the jar

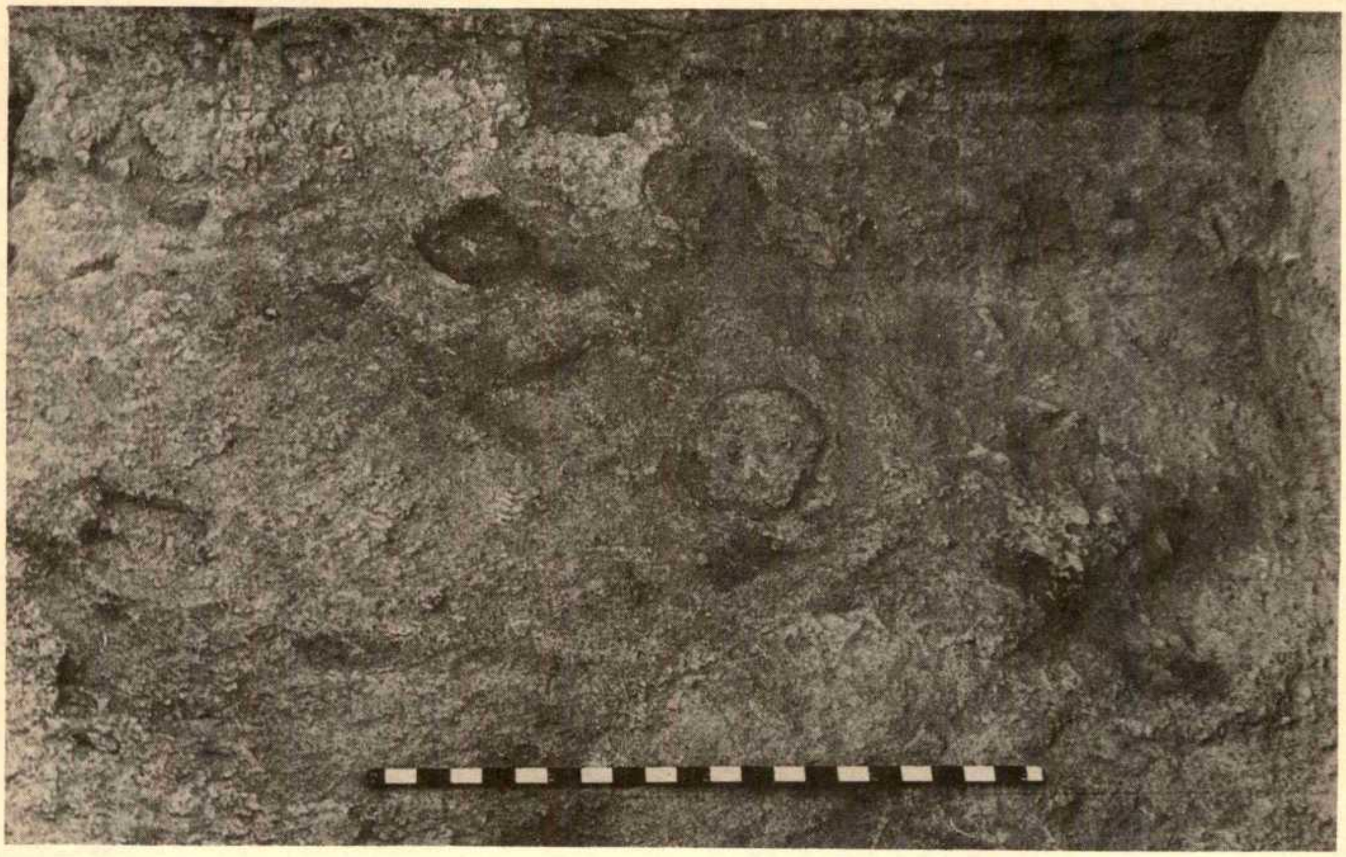

Fig. 7: Part of a rectangular mud structure, Period II

half of the jar bears three decorative motifs of horned headgear with loose hair, equi-distant from each other. Two other examples can be cited here. A horn-headed deity in gold from Hissar IIIc in Iran (Schmidt 1937: 189; fig III, pl. XLVI) and a painting on a pot at Kot Diji (Khan 1965: 57; fig. 16, pl. XVIIb) are more or less identical. In Hissar IIIc five horned gold sheets with a depiction of a mouflon (wild mountain sheep of southern Europe) or ibex were found in a hoard. These horned sheets bore seven pairs of perforations through the long coiled horns and the beard of the animal. In the case of the Kot Diji motif, a six-petalled flower is seen within the stylized bucranian horns. From the junction of the horns there appears to hang an elongated human head, with its chin and cheeks outlined with black dots, while the lower part of the forehead and the upper part of the long drooping ears are in black colour. The horns depicted on the Harappan pot resemble those of a special breed of bull found in Saurashtra and Kuchch and locally known as *kankrej*. The motif, depicted on the pot from Padri can be regarded as a different representation of *pasupati*, the lord of beasts. The neck, waist and the base of the jar each bear a horizontal band (Shinde 1991b).

The coarse variety of ceramics is represented by two wares, the Red/Grey and Padri. The Red/Grey ware is made from a very coarse clay, to which was added chopped grass and sand as tempering material. This was medium thick in section and wheel-made. A grey slip was applied on the outer surface, but sometimes blotches of red colour also occur, hence the sobriquet Red/Grey. The ware is unpainted but sometimes applique or punctured decorations on the neck and shoulders can be discerned. A medium sized globular pot with out-turned rim is the predominant type, whereas the other types such as the dish and small basin are very rare.

From the middle levels of the Harappan period, numerous sherds of a new painted ceramic have been collected. This new variety of ceramic was named "Padri ware" after the site. It is made from coarse clay and treated with a thick coating of red slip, which shows a tendency to develop cracks. In this connection it should be noted that there is a great deal of similarity between the "Savalda ware" reported from sites like Savalda (Sali 1964) and Kaothe (Dhavalikar *et al.* 1990) in the central Tapi basin and the ware from Padri. The Savalda ware is also coarse in fabric and treated with a thick red slip, which tends to develop cracks. However, this ware is rich in its repertoire of painted decoration and form (Shinde 1990a). The Padri ware is represented only by convex-sided bowls and globular pots. Interestingly, a couple of sherds of perforated jars have also been found in this ware. Painted decorations, consisting mainly of linear patterns such as vertical and horizontal bands, were executed in black colour. This type of ware has not been reported from any other Harappan site so far. It is therefore necessary to understand the genesis of this ware and its relationship with the Harappan culture. It is not unlikely that a number of local cultures in Saurashtra were contemporaneous with the Harappans and that there was a considerable exchange of cultural traits and possibly even some degree of peaceful co-existence.

Structures

Usually the Harappans in Gujarat are known to have used stone, mud bricks or burnt bricks as building material. In the absence of any trace of these materials at Padri, it was hypothesized that the Harappans at Padri lived in mud houses. A small excavation has corroborated our hypothesis, yielding two rectangular mud structures with low mud walls that were probably meant to keep out rain water. This is perhaps the first time that a rectangular mud structure has been uncovered in the Harappan levels anywhere in Gujarat. A number of other rural Harappan settlements like Kanewal, Zekda, Valabhi and Vagad in Saurashtra have produced evidence of circular mud huts (Sonawane and Mehta 1985). The rectangular structures unearthed at Padri are similar to those found in the Chalcolithic levels in the Deccan, particularly at Inamgaon (District Poona) and at Daimabad (District Ahmednagar). However, the limited excavation at Padri has not yielded any evidence of the construction over the low mud walls of wattle-and-daub screens which were one of the characteristic features of the mud houses of the Deccan Chalcolithic culture. The absence of stone structures at Padri can be attributed to the non-availability of raw material within a radius of 30 km of the site.

Structure No. 1: Structure No.1 was first noticed at a depth of 2.8 m in J2, beneath layer (7). A large part of the structure (4.7 m E-W X 3 m N-S) lies in this trench, whereas a small part of it remains in trench K2 which is unexcavated (Fig. 7). The structure is rectangular in plan, with low mud walls and post-holes on the periphery. The house floor was first noticed in the western half of J2 while clearing the thin layer of clay and ash lying on the burnt floor. Besides, the wall of the structure was clearly visible in the eastern half of the northern section which faces south, and is 0.55 m high and 0.45 m thick. The house floor, which was disturbed at places by later pits, was made of yellow silt mixed with fine sand and rammed hard. It was slipped with cowdung periodically.

Along the southern section of the trench was a mud wall, 0.52 m thick and 0.20 m high. Two post-holes in the southern wall, were located in the southwestern corner. The average diameter of the post-hole is 0.20 m. This southern wall of the structure was made from a mixture of fine silt and clay. The wall runs in an east-west direction and a small part of it (0.80 m) was cut in the eastern half while excavating. In the central part of the structure, at a distance of 2.2 m from the southern section there was a circular hearth (0.20 m in diameter) with a clay stem in the centre. This discovery is very significant because similar hearths were in use in the Deccan during the Chalcolithic period.

Most probably the house was abandoned because it got burnt. The intensity of the fire was such that even the walls and the house floor were burnt red. The earlier floor level of this structure was also noticed in the eastern part of the trench, 0.20 m below the upper floor. A thick layer of ash and burnt earth occurred over the earlier floor level, which suggests that the house was destroyed by fire twice.

Structure No. 2: In the western part of C3, at the bottom of layer (7), another rectangular mud structure similar to that exposed in J2 (St. 1), was observed. The small part of the structure visible in this trench suggests that it may have been rectangular in plan. It measures 2.6 m (N-S) and 0.81 m (E-W). The house floor is made of alternate layers of silt and clay frequently plastered with cow dung and lime. No post-holes could be observed because the periphery of the structure underlies the unexcavated portion .The thickness of the floor, visible in the section, is 0.12 m. The mud wall (0.50 m thick and 2 m long) running through the centre of the structure, appears to be a partition wall as it divides the house floor into two parts. It was not possible to measure the dimensions of the structure as a large part of it remained unexposed. Approximately in the centre of the northern half of the structure, a long cattle bone and a few large potsherds were found lying flat on the floor. The southern part of the floor appears to be uneven and contains small pebbles.

Discussion

The small excavation at Padri has produced very interesting evidence in the form of rectangular mud structures, three unusually large painted storage jars and a new ceramic. The author believes that the Harappans played a major role in the development of Chalcolithic cultures in the Deccan (Shinde 1989, 1990b, 1991c), and for the first time the excavation at Padri has furnished some positive evidence in this regard. The characteristic features of the Deccan Chalcolithic culture include rectangular mud houses, painted pottery and a restricted use of copper. The technical know-how for producing painted pottery and copper articles was possibly acquired from the Harappans by the Deccan Chalcolithic people, as the former were the first in India to make and use them. The discovery of rectangular mud houses at Padri and a circular domestic hearth with a stem in the centre provide further evidence of close contact between the two cultures. The discovery of a small globular jar with a beaded rim and decorated with a panel of hatched diamonds assumes significance in the light of the predominance of this type and design in the ceramic assemblage of the Deccan Chalcolithic culture. The ceramic assemblage from the excavations at

Kaothe in District Dhule of Maharashtra has revealed a high percentage (nearly 50%) of Harappan traditions (Dhavalikar and Shinde 1989, Dhavalikar *et al.* 1990). As Kaothe is close to the Gujarat border and is situated within the peripheral zone of the Harappan culture, a greater cultural influence can be expected. It will, therefore, not be far fetched to surmise that the Harappans with the decline in their prosperity began to migrate to the Deccan around the beginning of the second millennium B.C. The discovery of a new ware and its similarity with the Savalda ware is further proof of the close contact between the cultures of these two regions.

The excavation at Padri has not produced any evidence pertaining to the function of this site. A detailed site survey had led us to postulate that it was a centre where shell objects were manufactured. However, the excavation has yielded barely two shell beads and hardly any trace of debitage. The settlement is located in a place without adequate security, and at a considerable distance from a source of drinking water and good arable land. The proximity of the site to the sea and the discovery of three large sturdy storage jars, along with a large number of sherds of similar type, suggest that Padri was a salt manufacturing centre. Such costly well fired jars would generally be required to store and transport salt to different places. However, further work needs to be carried out to establish the function of the site and the nature of the settlement at Padri. The discovery of the motifs of a horned deity suggests an early date, although the ceramic assemblage is similar to that of Rojdi B, which has been dated between c. 2200-2000 B.C. (Possehl and Raval 1989: 171).

The re-establishment of a settlement at Padri in the 1st century B.C. after its desertion by the Harappans is really enigmatic, although the purpose of re-occupation could have been the same as it was during the Harappan period.

Acknowledgments

The author is extremely grateful to Professor V.N. Misra, Director, and Professor S.N. Rajaguru, Joint Director, Deccan College Post-Graduate and Research Institute for their encouragement and support to this project. In the pre-excavation stage he was benefited by discussions with Professor Gregory Possehl of the Pennsylvania University, U.S.A. who also offered very valuable assistance at a critical stage, for which the author is grateful. A small but fully dedicated team, which included Dr. R.K. Mohanthy, Mr. Y.S. Rasar, Miss Sonya Bhagat, Miss Seema Pavankar, Miss Savita Pandey, Mr. M. Hoque, Mr. M. Koiso and Mrs. Chihiro, were behind the success of this project and their help is gratefully acknowledged. Dr. Maheshbhai Pandya of Padri village deserves special thanks for his painstaking efforts to help us during the course of our excavation.

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Buffalo-Horned Human Figure on the Harappan Jar at Padri — A Note

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The discovery of a huge Harappan jar by Dr. V.S. Shinde (1991) from the excavations at Padri, District Bhavanagar, Gujarat is, indeed, very significant. On its surface is a painting in black of a buffalo-horned human figure wearing a lower garment which, according to the excavator, looks like a grass-skirt. It may shed welcome light on the nature of the buffalo-horned anthropomorphic representation termed by archaeologists as a buffalo-deity (Allchin B. and R. 1982: 163).

In tiny and incomplete forms, painted human figures with sharp buffalo horns have been found on potsherds and terracotta cakes at various protohistoric sites like Kot Diji, Burzahom, Gumla, Rahman Dheri, Sarai Khola and Levandheri. On the polychrome painted pot from the last named site, only the horns are delineated (Allchin B. and R. 1982, Fig. 6.32). But at Kot Diji a tiny head is suspended from massive horns. The depiction on the Burzahom pot is almost similar. On one of the two Gumla pots, however, the silhouette of a body below the head gives an impression of anthropomorphism (Sankalia 1974: 341, Fig. 88k, b, c, e). The figure incised on the Kalibangan broken terracotta cake leaves no doubt about its anthropomorphism. The figure is visible up to the waist, but the lower part is broken away (Allchin and Allchin 1983, Fig. 6.31). For the first time, the painting on the Padri jar shows the complete human figure measuring more than 17 cms below the horns. It is in the standing (*sthānaka*) posture. Surmounted by sharp buffalo horns, the figure wears a lower garment, shown by wavy lines extending from the waist to the knees.

The horned anthropomorphic figures on the bowl, the pot and the jar are linked up by archaeologists with the similar, but not identical buffalo-horned human figure on Harappan seals. The Allchins observe, with reference to the figure on ceramic ware "… that it anticipates the horned deity of the Mature Indus period seems beyond doubt" (Allchin B. and R. 1982: 163). Much more emphatically Parpola remarks, "The evidence shows that the Harappan Proto-Siva has a long local prehistory" (Parpola 1981: 181).

However, the identification of the horned deity on pots, bowls and jars with a similar figure on the Mohenjodaro seals is neither necessary nor desirable. Iconographically they are different. If on the three seals at Mohenjo-daro, including that of the so-called Proto-Siva, the figure is shown as seated on a dais or throne in a yogic posture, the deity on the pots is in the *sthānaka* posture without any yogic association, but wearing a grass skirt, which is conspicuous by its absence on the figures on the seals. Functionally, pots and seals are different. Seals are meant to authenticate an object, while pots, bowls and jars are containers used for storage or for drinking and eating from.

The painted pots found during explorations or from excavated sites constitute a very tiny segment of the total ceramic component recovered from archaeological sites. This small quantity places these painted pots in a distinctive category indicating their special function for storage, eating or drinking. However, from the usual archaeological methods of observation, analogy and inference it is well-nigh impossible to define precisely the nature and significance of the distinctive function of these special ceramic types. However, if they could be linked with the horned human figure in a ritualistic context, known either from a definite and consistent tradition or from contemporary documents, adequate and satisfactory explanation for their use can be offered. Iconology in the sense of semantics of form may serve as a bridge between the material object and its symbolic meaning in a functional context.

In view of this, we proceed with the hypothesis that the Padri jar is a ritual pot and that the buffalo-horned image painted on it is a symbol which has a functional relationship to it in a ritual context. We also hypothetically take the Ṛigveda as the basis of the interpretation of symbols — the hermaneutics of symbolic expression, despite the fact that the relationship of the Vedas with the Harappan culture is still problematic. Setting aside, for the time being, the problem of the relationship between the Vedas and the Harappan culture, we might attempt to discover, experimentally, whether or not on this hypothesis a consistent and satisfactory explanation of the symbol on the pot and the interrelated function of the pot can be found.

As in other archaic communities, so also during the Vedic period, there was a strong and effective tradition of the use of symbols in rituals. Symbols called *añji* or *lakshma-lakshaṇa* served a three-fold purpose — to create auspiciousness, to ward off evil and to invigorate the character of objects used in ritual. Sacrificial posts were decked out with *añjis* (*RV*. 1.3.6.13). *Lakshaṇa* the symbol is a denominator of character or the nature of the article which bears it. *Ashadha* "bricks are symbol-bearing and hence they say of him, who has a sign on everyside that he has a lucky auspicious character" (*Śatapatha Brāhmaṇa*, 8.5.4.3). Without a symbol, an object is devoid of character — *yadvai nāsti tadalakshaṇam* (*Ibid*.: 7.2.1.7). A verse from the funeral hymn of the *Atharva-Veda* (XII: 3.22) when read in accordance with the *viniyoga* laid down in the *Kauśika Sūtra* (61.30) indicates that the form of the dead person was inscribed (*likhita*) on the pot (*kumbhī*) by means of a stylus (*arpaṇa*).

Thus, the Padri jar may be taken as a ritual pot with the horned human figure as the symbol explaining its nature, related to the function of the pot in a ritual context. The symbologism of the anthropomorph, the significance of buffalo-horns and the skirt is to be understood in a meaningful holistic complex related to the function of the jar.

(a) The Buffalo or to use the Sanskrit equivalent *Mahisha* is an epithet particularly applied to *Soma* in the *Rigveda*, though it is sometimes used by way of analogy for Indra, Agni, Marutas, Varuṇa and the Aśvinas. "Soma, the Mahisha, shines as the Lord, desiring to divide in shares the splendour of heaven, the third region". (*RV*: 9.16.18) "Great are indeed the deeds of Soma, the Mahisha" (9.97.41). As many as seven times, Mahisha figures in the 9th *maṇḍala* of the *Rigveda* either as an epithet or by way of comparison with Soma (9.16.18; 19; 9.86.40; 9.97.41; 9.113.3; 9.73.2; 9.86.25)

(b) Among the horned deities of the *Rigveda*, Soma, the personified form of the sacred plant is quite prominent. The adjective *tigma-śṛinga* 'having sharp horns' figures six times in the *Rigveda*, out of which as many as five times, it qualifies Soma (6.16.39; 7.19.1; 9.97.9; 10.48.10; 10.86.5). Besides, there are two references where Soma is described as 'sharpening his horns' (9.15.4; 9.70.7).

(c) The grass-skirt or to call it by its Vedic name, *tārpya* finds mention several times in Vedic literature. We shall start our short survey from the Brāhmaṇas, and move backwards to the Samhitas. The *Taittirīya Brāhmaṇa* (I. 3.7.1) brings out the ritualistic significance of the grass garment: 'He causes the sacrificer to wear *tārpya*. *Tārpya* is indeed, the sacrifice. He perfects himself (thus) through sacrifice. He makes him put on (the *tārpya*) made of *darbha* grass. Pure are the *darbha* grass-blades. Hence it, i.e., *tārpya* purifies him."

The nature and composition of the garment is rendered clear by a significant passage in the '*Śatapatha Brāhmaṇa*' (5.2.1.8) "Thereupon the Neshtri, being about to lead up the (Sacrificer's) wife makes her wrap around herself, over the garment of consecration, a cloth or skirt made of *Kusa* grass". The text explicitly describes the garment as a skirt (*chaṇḍātaka*) and points out that the purifying garment is made up of *kuśa* grass.

Tārpya, the word in this form, is mentioned for the first time in a funeral hymn of the *Atharvaveda* (18.4.3.1) where the dead person is exhorted: "This garment god Savitri gives the to wear; putting on that, which *tārpya*, do thou go about in Yama's realm'. However, *tṛipra* and *tṛipala*, earlier forms of *tārpya* occur respectively once (8.2.5) and twice (9.97.8; 10.89.5) in the *Rigveda*, and all of them are the adjectives of Soma.

En passant, we may note that the *tārpya* was essentially a ritual royal dress. In the *Śatapatha Brāhmaṇa* (5.3.5.20), the *tārpya* is put on while reciting the formula "thou art the foetus of the *kshatra* (power)" and "he thus causes him to be born from out of what is the foetus of the *kshatra* (power)".

Soma is the king par excellence. He was the *prathamo rājā* 'the primeval king'. (*RV*. 10.109.2; *AV*. 6.104.3). His sobriquet *rājan* (king) so popular in later Vedic literature figures also in the *Rigveda* (6.15.18). Therefore the royal ritual garb is the fitting apparel for him.

Thus all the characteristics, — the buffalo, horn and grass-skirt converge in the personified form of Soma, the sacred creeper.

The juice of Soma was stored in a pot called *Soma-dhāna kalaśa* in the *Rigveda* (6.69.2; 6; 9.97.33). These references indicate that it was a big jar (likened with *samudra* in 6.96.6) with a wide mouth capable of receiving multiple pourings of Soma. *Kalasa* was an earthenpot in contradictinction to *droṇa*, which was a wooden trough. An elaborate system of rites centres round the distillation, storage and distribution of Soma juice, in which *Soma-dhāna kalaśa* (Soma storage jar) had a role to fill.

Thus, it appears that the Padri Harappan jar was a *Soma-dhāna kalaśa*, and the anthropomorphic figure with the horns of a buffalo and grass-skirt represents Soma delineated on the jar to reinforce its identity. The question may, however, be raised. Was it at all necessary to paint the figure of Soma on the pot to establish the identity of the pot for those participants of sacrifice, who by virtue of their knowledge of various rites connected with it would not have required any recognition device? The answer is simple. The figure is not an *aide memoire* but a *lakshaṇa*, the symbol having the supernatural capacity to endow the essential character to an object, as in the case of the *āshādhā* brick. Such a reinforcing symbol might have been necessary in view of the fact that in Gujarat, far away from the Mujavat Mountains where Soma used to grow, it was well-nigh impossible to find fresh Soma plants for distillation. In accordance with the Vedic injunction, however, a substitute of Soma might have been used. The *Śatapatha Brāhmaṇa* (4.5.10.1-6) gives a list of substitutes in order of preference — the phālgunī plants which have brown flowers, the syena-bhṛita, adara, brown Dūrva, and yellow kuśa. Consequently it might have been necessary to depict the figure of Soma as a *lakshaṇa*, the symbol for supernaturally generating the character of Soma.

Probably because need for such reinforcement, the composition on the Padri jar, also includes the vegetal form of Soma, as the *syena-bhṛita* motif. In the *Ṛigveda*, Soma is styled as "borne by syena" (1.80.2; 8.15.3; 9.87.6). For Indra, Syena, the bird, plucked Soma stalks and brought them' — *ādāya Syena = bharat = Somo*. (4.26.7). Also *dadamāno amśum* (4.26.6). "Syena bearing Soma stalks".

On the left of the horned anthropomorph, is a linear design showing a fast flying bird with stalks in his beak. The flight of the bird is beautifully depicted by undulating lines, and the stalks are shown as sticks with globular ends. From the bird there is a downward flow of honey — *madhvaja-bhāra* (4.18.13) — shown as vertical wavy lines indicating this pouring down of honey.

So consistent and rationally tenable is this explanation of the horned human figure, the function of the jar and their ritual inter-relationship, that I propose to identify the horned anthropomorph as Soma and the Harappan jar at Padri as *Soma-dhāna kalaśa* 'the jar for storing the Soma juice'. The onus of giving an alternative explanation lies with them who differ with this explanation on the grounds of the problematic relationship between the Harappan culture and the Vedas.

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Prehistoric and Protohistoric Investigations in the Eleru Valley, North Coastal Andhra Pradesh

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Abstract

This paper summarises the author's work in the Eleru valley. It discusses the techno-typology and cultural similarities of the Upper Palaeolithic, Mesolithic and Neolithic assemblages discovered, as well as the archaeological potential of the region for reconstructing the subsistence and settlement patterns of the prehistoric people.

Introduction

The Eleru river valley is confined to the north and northeastern parts of East Godavari District and lies between 81° 40' and 82° 25' E and 17° and 18° N. During the early part of this century pioneering discoveries were made by Cammiade (1924) to unravel the prehistory of this area. He discovered over a hundred sites of 'pygmy implements' (microliths) in the Polavaram, Rampachodavaram, Ellavaram and Peddapuram taluks of West and East Godavari Districts. The latter two taluks are drained by the Eleru river. Subsequently, there was a complete lull for about half a century until 1976 when the author undertook a survey of the valley, covering the main river and its tributaries like the Madigedda, Madieru and Donigedda (Kasturi Bai 1982).

The Eleru is a perennial river. It rises at a height of 1275 m above msl in the Eastern Ghats and flows eastwards along the coastal plain for a distance of 140 km before emptying itself into the Bay of Bengal, near Uppada. Topographically the study area can be broadly divided into three zones: 1) the hilly tracts, 2) the uplands and 3) the delta. The major part of the Ellavaram taluk is covered by the hilly tract, whose ranges rise in altitude between 450 m and 900 m above msl. The upland zone is a gently undulating terrain dotted with isolated hills, covering parts of Ellavaram and Peddapuram taluks and ranging in elevation between 150 m and 450 m above msl. The delta lies south of Eleswaram and is the most fertile alluvial stretch of the Eleru valley, with occasional hillocks dotting the region.

Geologically the region is represented by Archaean crystallines, Rajamundry sandstones of Tertiary age and Quaternary alluvial deposits. The Khondalite series is the oldest rock formation in the area. Quartzites are observed as bands and veins traversing the formations and these were exploited by prehistoric people for making stone tools. The climate of the area is characterized by hot summers, mild winters and good seasonal rainfall. The average annual rainfall is 1295 mm and the area receives both the SW and NE monsoons. Tropical dry deciduous forests are widespread in the hilly tract, while thorny scrub covers the upland zone where a large number of prehistoric sites have been found. A variety of tubers, flowers, fruit, berries, edible leaves and honey are abundantly available in the forests. Small and big game such as gaur, sambar, spotted deer, rabbit, hare, wild boar and a variety of birds and jungle fowl are available in plenty.

The author discovered a total of 57 Stone Age sites in the area. There are 27 Upper Palaeolithic, 22 Mesolithic and 8 Neolithic sites, of which 32 have been shown in Fig. 1. The eleven sites earlier reported by Cammiade were revisited and of these only 6 yielded microliths. The Stone Age sites of the Eleru basin comprise single, double or multicultural material and are located mostly on the fluvial sediment surface with only a couple on the pediment surface, but always close to a source of water.

As yet there is no evidence for distinctive Lower and Middle Palaeolithic cultures from the valley. However, a few water-worn bifacial tools were recovered from the modern bed of the river. A few rolled Middle Palaeolithic implements were also collected, along with Upper Palaeolithic tools, from three places, namely, Eleswaram I, Pakala and Rajavumangi. These comprised 9 flakes and one miniature handaxe made from fine-grained quartzite.

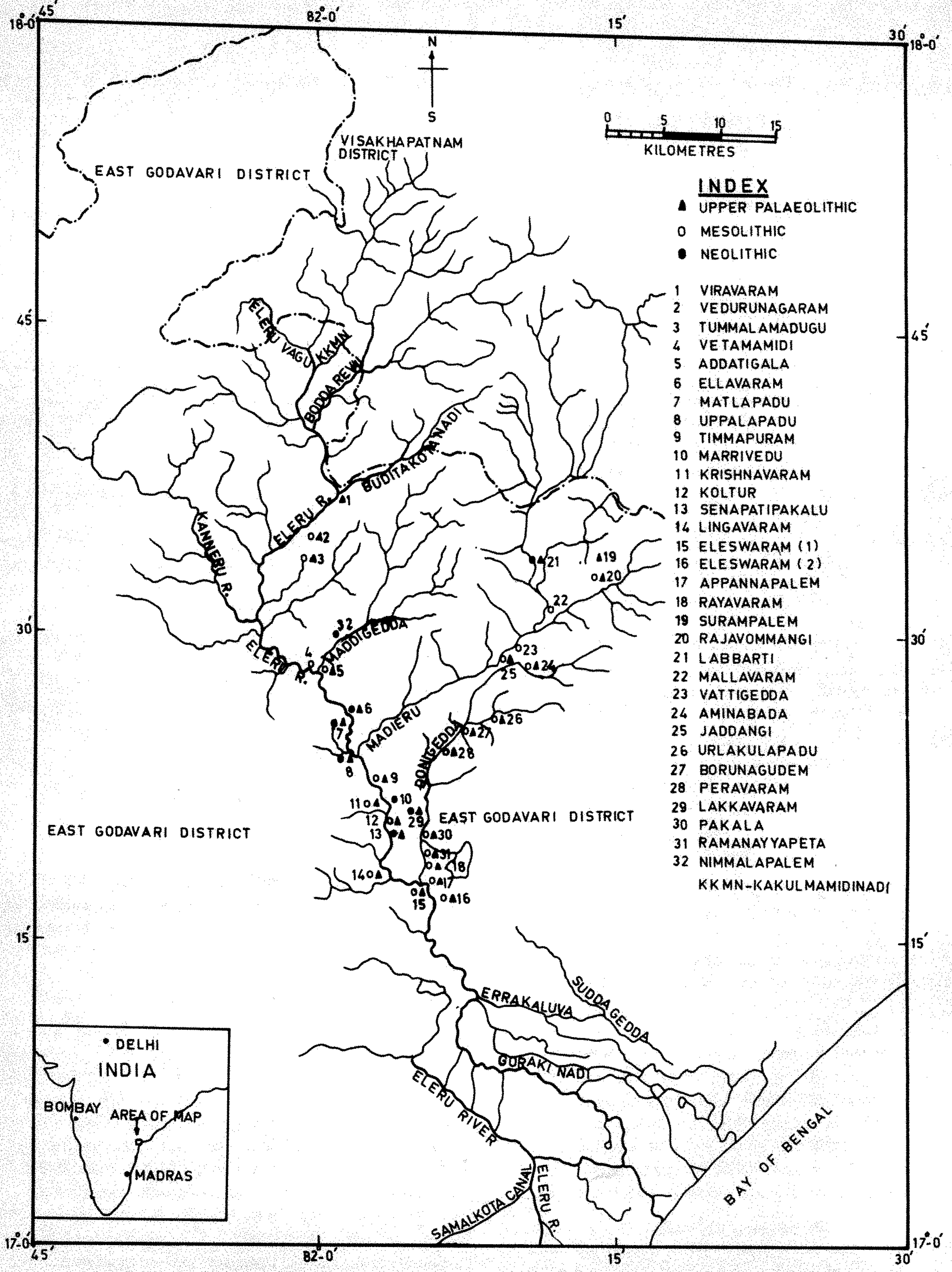

Fig. 1: Prehistoric and Protohistoric sites in the Eleru River Valley

Upper Palaeolithic (Fig. 2: a-g)

This cultural phase is well represented in the Valley. The 27 sites are distributed along the river Eleru (16 sites) and its tributaries — the Madieru (3 sites) and the Donigedda (8 sites). A total of 1064 artefacts were collected from these sites. The majority of the artefacts are made of quartzite followed by quartz, chert, agate, carnelian and chalcedony. The artefacts are in mint-fresh condition and are in a near primary context, indicating that the activity area was within the vicinity. The tool kit consists of a variety of shaped tools (436: 40.97%) and simple artefacts (628: 59.03%). The debitage amounts to several hundred pieces of chips and flakes. The finished tools include — in diminishing order — scrapers (106: 24.36%), backed pieces (90: 20.68%), retouched flakes (87: 20%), retouched blades (41: 9.43%), points (23: 5.29%), retouched flake-blades (22: 4.83%), borers (21: 4.83%), lunates (19: 4.39%), burins (13: 2.99%), awls (5: 1.15%), borer-cum-scrapers (4: 0.92%), triangles (3: 0.69%), an awl-cum-scraper (1: 0.23%) and a trapeze (1: 0.23%). The simple artefacts comprise flakes (358: 57%), flake-blades (141: 22.45%), blades (70: 11.14%), blade cores (23: 3.66%), Levallois cores (11: 1.75%) and amorphous cores (25: 3.98%). The presence of flakes and the large quantity of debitage suggest a primary nature of their occurrence.

Out of 27 sites, 4 sites (Eleswaram I and II, Rayavaram and Ramanayya Pet) have yielded artefacts ranging from 80 to 456 specimens. At three other sites (Upplapadu, Pakala and Bornagudem) the artefacts range from 30 to 50 specimens, while the rest of the sites yield anywhere between 2 and 16 artefacts. On the basis of artefactual yield and aerial extent these sites are regarded as big and medium base camps and single episode or transitory sites.

The Upper Palaeolithic industry in the Eleru valley is characterized by flakes (47.71%), followed by flake-blades (29.82%), blades (20.41%) and cores tools (2.06%) in the shaped tools category. Although the collection has a few lunates, triangles and trapezes the absence of standardized blade tools is remarkable. This assemblage, has therefore been assigned to the flake-blade category of the Indian Upper Palaeolithic.

Mesolithic (Fig. 2: h-p)

There are 22 Mesolithic sites in the Valley. Twelve are situated on the main river and the rest (12) on the Eleru's tributaries: e.g. the Donigedda (7) and the Madieru (3). A total of 2045 artefacts were collected and as in the case of the Upper Palaeolithic, the rock types used for manufacturing the artefacts are chert, chalcedony, carnelian, quartz, quartzite, etc. These raw materials are readily available in the river gravel. The majority of the artefacts are made from quartzite and quartz. The fluted core technique has been chiefly employed for removing blades and the pressure technique for edge retouching. The assemblage has 724 (35.41%) shaped tools and 1321 (64.59%) simple artefacts. The shaped tools include backed pieces (214: 29.63%), retouched blades (119: 16.44%), scrapers (110: 15.19%), points (86: 11.88%), retouched flakes (59: 8.15%), lunates (41: 5.66%), borers (28: 3.86%), burins (19: 2.62%), triangles (19: 2.62%), awls (14: 1.93%), trapezes (10: 1.62%) and borer-cum-scrapers (5: 0.69%). The simple artefacts include the following: flake cores (499: 37.77%), amorphous flakes (261: 19.76%); used blades (233: 17.64%); used flakes (116:8.78%), simple flakes (84: 6.36%), simple blades (56: 4.24%), plunged flakes (43: 3.26%) and core rejuvenation flakes (29: 2.20). The presence of flakes, cores and debitage suggests that these were work-cum-base camps of the Mesolithic period.

Out of 22 Mesolithic sites, 4 (Eleswaram I and II, Ramanayya Pet and Rayavaram) have yielded 100 to 500 artefacts; 8 sites 25 to 100; and the remaining 10 sites less than 25 artefacts. The Mesolithic industry in the Eleru valley is typically pre-pottery Mesolithic and compares well with similar industries in other parts of peninsular India.

Neolithic (Fig. 2: q, r)

Evidence for the Neolithic is comparatively poor in the Eleru valley and only 8 sites were identified. These are distributed on the river Eleru (5 sites) and 2 of its tributaries, the Madigedda (1) and the Madieru (1). These sites, unlike the pre-Neolithic ones, are located in the savanna woodland tract at the foot of the adjacent hills, half to one kilometre away from the river bank. The sites have yielded pecked- and ground-stone axes, blade and ceramic industries. None of the sites have yielded a thick habitation deposit like many other south Indian Neolithic sites.

The pecked- and ground-stone industry (26 tools) includes both edge tools (15) and non-edge tools (11). These are made from Charnokites, Khondalites and sandstones which are readily available in the vicinity of the sites. The edge tools (Fig. 2) consist of a round butt axe (1), adzes (8) and small celts such as quadrangular (2), triangular (3) and trapezoidal (1) examples. The non-edge tools are: perforated stones (10) and rubber stones (1). The edge tools from the Eleru valley are similar to those of the eastern Indian Neolithic.

The blade industry is fashioned on cryptocrystalline silica as generally used in the Mesolithic. All the sites have yielded blade tools (except Nimmalapalem) totalling 462 artefacts. The Neolithic blade tool assemblage is akin to that of the Mesolithic in the valley but differs technologically from the south Indian Neolithic blade industry. The blades in the latter are long and were removed by the crested guided ridge technique which is completely absent in the Eleru blade industry where the fluted core technique was employed. There are 194 (42%) finished tools and the simple artefacts such as flakes, blades and cores constitute 268

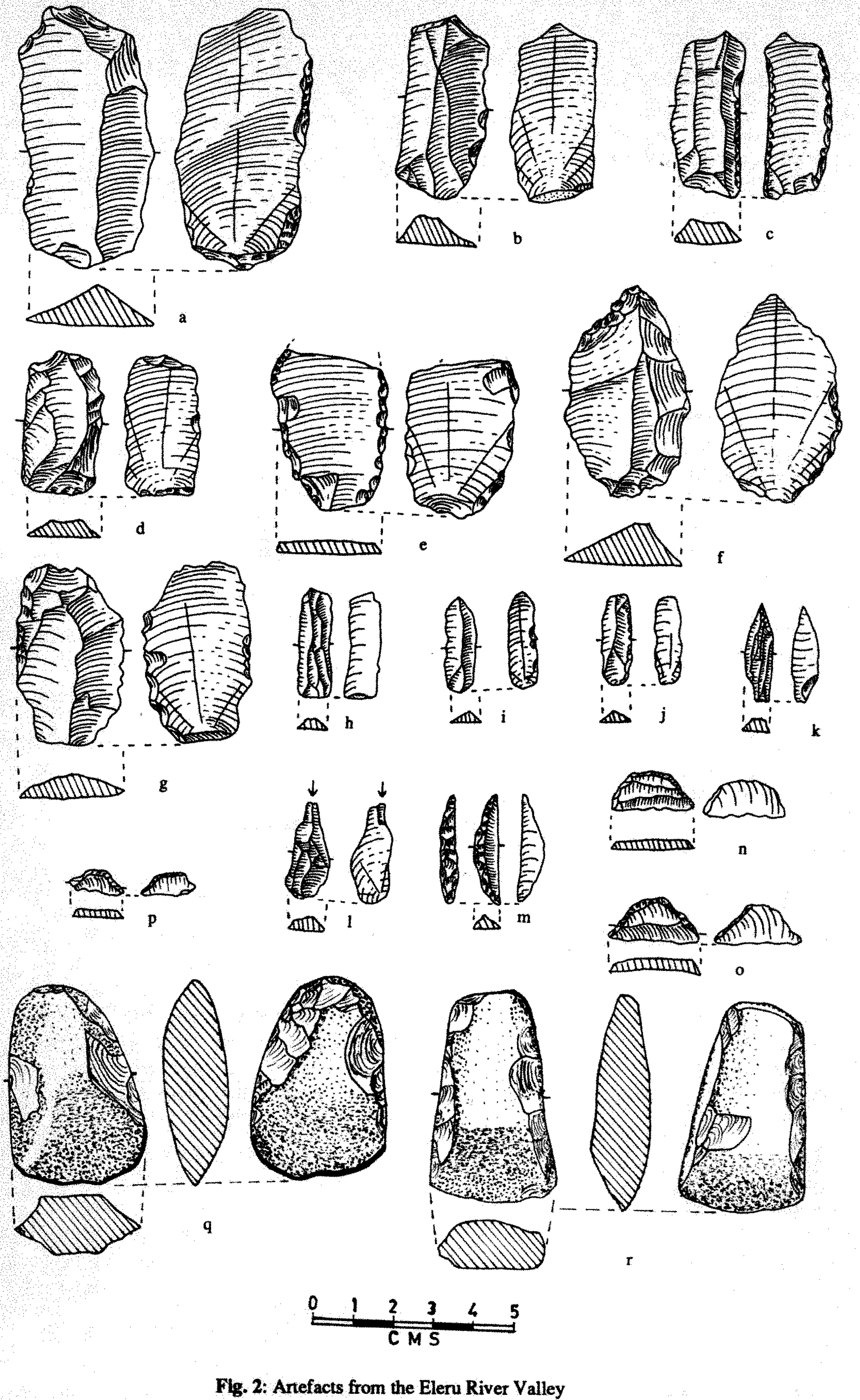

Fig. 2: Artefacts from the Eleru River Valley
Upper Palaeolithic: a-d = Blades; e = broken blade; f-g = flake blades
Mesolithic: h-j = blades; k = owl; l = burin; m = crescentic point; n = lunate; o-p = trapezes
Neolithic: q = round-butt axe; r = quadrangular adze

(58%), excluding debitage. The finished tools are represented by backed pieces (62: 32.47%), points (39: 20.10%), lunates (25: 12.88%), scrapers (22: 11.34%), retouched flakes (16: 8.25%), retouched blades (12: 6.19%), triangles (5: 2.58%), awls (4: 2.06%), borers (3: 1.55%), trapezes (3: 1.55%) and burins (2: 1.03%) in that order. Evidence for a ceramic industry comes from 6 sites and is characterized by a coarse gritty red ware and is represented by globular vases with angular necks and flared rims, wide-mouthed deep bowls with featureless rims, narrow tubular-necked vases and lipped bowls. The coarse gritty red ware is the characteristic pottery found at Kuchai (Thapar 1964) in the Mayurbhanj district of Orissa, and is the extension of the eastern Indian Neolithic culture.

The occurrence of edge tools like triangular and trapezoidal celts, a short blade industry, the pottery fabric and an absence of thick habitation deposits in the Eleru valley point to similarities between it and the eastern Indian Neolithic.

The majority of the Upper Palaeolithic and Mesolithic sites are located in the middle reaches of the river and its tributaries. This region with its perennial water supply, availability of raw material for stone tools, tropical thorny forest with plenty of small and big game and edible plant produce must have sustained prehistoric habitation during the late Pleistocene and early Holocene times.

The valley at present supports the Koyas, Konda Kapus and Konda Doras tribes whose subsistence economy is mainly based on gathering, hunting, fishing and primitive agriculture. The stone age sites are also contiguous with the tribal settlements in the valley. A study of ethnographic analogies should throw new light on the life of prehistoric peoples in the valley.

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Archaeological Investigations in the Submergence Area of the Narmada Sagar Dam, Madhya Pradesh: A Reconnaissance Survey

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Abstract

The Nimar District of Madhya Pradesh, forms a portion of the area to be submerged by the Narmada Sagar Dam. Preliminary explorations carried out in the area have revealed a continuous succession of archaeological deposits from Acheulian to recent historical times. This paper highlights the archaeological potential of the area so that plans can be formulated to salvage these remains before the area is fully submerged.

Introduction

The Narmada Sagar Dam is one of two major dams to be constructed on the Narmda river. This is supposed to be one of the largest river valley projects ever undertaken in the world and one anticipates a tremendous archaeological loss resulting from the vast area to be submerged.

Unfortunately no planned investigation has yet been undertaken to uncover the archaeological remains in the area except for some exploratory work which was carried out by C. Krishna (1984) in East Nimar District. It is surprising that this work has been completely ignored during preparation of the crucial report on Archaeology and Culture, which was submitted to the Department of Environment in 1984. This preliminary report, prepared by the Environmental Planning and Coordination Organization, Bhopal, states that in spite of the Narmada Valley being extremely rich in archaeological sites, only *Singhji-ki-Samadhi*, a late medieval structure falls within the submergence area. It would therefore, not be unreasonable to conclude that the advice of archaeologists regarding the archaeological heritage of this area has been considered of little importance in respect of the loss that will be suffered due to submergence. In addition the map of the area of submergence clearly indicates the existence of temples and deserted villages which have been overlooked in the preparation of the report. Therefore, there is an urgent need to look into the cultural past of the area and to document the endangered archaeological sites.

The Study Area

The first planned archaeological investigation was undertaken by the author in 1988 on behalf of the Prehistory Branch, Archaeological Survey of India, with a view to ascertaining the archaeological potential of the area to be submerged. This survey was confined to the Khandwa and Harsud tehsils in the northern part of East Nimar District. Out of a total 254 villages to be affected by the dam project only 167 villages were surveyed — 113 from January to March 1988. In the course of investigations it was noticed that certain villages which were not mentioned in the list of villages to be submerged would definitely either be wholly or partially submerged. Twenty such villages have been identified and investigated.

The Environment

The area can be divided into two broad physiographic divisions: (i) the Narmada valley with the Upper Vindhyan formations and (ii) the undulating plain composed of Deccan Trap. The former constitutes the Narmada and the Vindhyan hills, with luxuriant vegetation on both banks of the river. The hills rise conspicuously at certain places to more than 400 m above msl, whereas the Deccan Trap area is mainly an erosional landscape forming an undulating surface ranging in height from 246 m to 277 m above msl. A number of seasonal and perennial streams drain the area. Due to the thin soil cover on the Trap, the growth of vegetation is poor.

The northern part of the study area is drained by the Narmada which flows in an east-west direction, and also by the river Chhota Tawa, a tributary of the Narmada.

The geological history of the area with its various formations is as follows:

Holocene — Surface soil and younger alluvium
Pleistocene — Older alluvium
Upper Cretaceous to Eocene — Deccan Trap
Upper Cretaceous — Lameta beds
Late Precambrian — Upper Vindhyan System
Archaean — Bijawar Series, Granites and Gneisses

The area experiences four major seasons (i) the winter — from December to February, (ii) the summer — from March to May, (iii) the monsoon — from June to September and (iv) a post-monsoon season during October and November.

The average annual rainfall is 880 mm. The hottest month is May, the average temperature being 34.55° Celsius, whereas December is the coldest month with an average temperature of 19.96° Celsius.

The vegetation belongs to the dry deciduous type and the area supports various kinds of wild fauna.

Method of Survey

At the outset it may be mentioned that because of limited time, the present investigation was in the nature of a reconnaissance survey. Therefore, it has not been possible to record all the archaeological remains and many may have been overlooked. The main sampling strategy followed is the survey of archaeological sites in various ecozones. However, in spite of these limitations, the evidence brought to light during this investigation is adequate to provide a picture of the archaeological potential of this area.

Archaeological Evidence

The following is an inventory of various archaeological remains brought to light from a total of 113 villages covered during the course of the first season of investigation in 1988 (Ota 1988).

Table 1: A List of Archaeological Sites in the Submergence Area

Tehsil	Village	Cultural Assemblage
Khandwa	Balwara	Acheulian
	Jamoti	Acheulian, microlithic, and loose sculptures
	Purni	Acheulian (two localities), microlithic (two localities), early historical mound, medieval mound, and iron smelting site
	Chandel	Temple remains (c. 12th/13th century A.D.)
Harsud	Abhawa	Acheulian
	Amulni	Medieval mound
	Baihari (Bir)	Medieval mound
	Balri	Remains of a Siva temple (c. 12th/13th century A.D.) locally known as *Barkeshwar Mahadev mandir*, and medieval structural remains
	Bamangaon	Medieval mound
	Bandariya	Medieval mound
	Bargaon (Mal)	Medieval mound
	Barur	Medieval mound
	Belwari	Microlithic (two localities), and medieval site
	Beriya	Medieval mound
	Bhawarli	Medieval mounds (two), late medieval brick temple, and remnants of a stone temple
	Bijalpur Khurd	Acheulian (four localities), microlithic, early historical mound, loose sculptures, *sati* memorial stones, and iron smelting site
	Bijalpur Kalan	Medieval site with fortification locally known as 'Kotra', late medieval structures, remains of a temple (c. 12th/13th century A.D.)
	Billod	Microlithic
	Billod (Mal)	Medieval mound
	Blurari	Medieval mound
	Boribandri	Microlithic, and medieval mound
	Boribandri (Kherkheda)	Microlithic
	Chalpa Kalan	Early historical mound
	Charkhera	Microlithic (two localities), and medieval mound
	Chhirwan	Microlithic
	Chich	Medieval mound
	Chikhli	Medieval mounds (two)
	Dewaldi	Medieval mound
	Dagarkheri	Ruins of late medieval structure
	Ganor	Microlithic, medieval mound and iron smelting site
	Gehelgaon	Medieval mound
	Gehungaon (kalan)	Medieval mound
	Gondikhera	Microlithic
	Gullas	Middle Palaeolithic (two localities), and iron smelting site
	Haripura	Medieval site

Tehsil	Village	Cultural Assemblage
	Hathnora	Late medieval structural remains
	Harsud	Remains of a Vishnu temple (c. 12th/13th century A.D.) with loose sculptures, and medieval mound
	Jabgaon	Medieval mound
	Jaitapur Khurd	Microlithic
	Jalwan	Medieval mound
	Jhagria (Mal)	Medieval mound
	Jhirighat	Medieval mound
	Jogibira	Remains of a Siva temple (c. 12th/13th century A.D.), medieval mounds (three), loose sculptures, and *sati* memorial stones
	Junapani	Medieval mound
	Karauli	Microlithic
	Kashipura	Microlithic and medieval mound
	Kasrawad	Medieval mound
	Khudia (Mal)	Middle Palaeolithic, medieval mound, two late medieval Siva temples (of stone), and a late medieval brick temple
	Khutia	Medieval mound
	Kukdal	Middle Palaeolithic, remains of a temple with a Vishnu sculpture (c. 12th/13th century A.D.) and medieval mound
	Kuksi	Medieval mound
	Lachhora	Medieval mound
	Lodhisanthri	Medieval mound
	Mahatpur	Microlithic, and medieval site
	Malod	Microlithic
	Maujwari	Microlithic and medieval mound
	Nagpur	Microlithic, and *sati* memorial stones
	Nandgaon	Medieval mound
	Naoghata	Acheulian
	Nazarpur	Microlithic and medieval mound
	Newalkhera	Middle Palaeolithic, microlithic, early historical mound, loose sculpture of Vishnu
	Pangeria	Medieval site
	Panghat (Kalan)	Sculpture of Ganesa and an inscription in Devanagari script
	Singaji	Medieval sites (five), and a late medieval structure known as 'Singhji-ki-samadhi'.
	Saktapur	Medieval mound
	Sarai	Acheulian (two localities)
	Semrur (Mal)	Medieval mound
	Sodia	Microlithic and medieval site
	Sonpura	Medieval mound
	Susarel	Remains of a brick temple
	Torniya	Microlithic and temple remains

The Acheulian localities are confined to the southern fringe of the Vindhyan hills on the left bank of the Narmada. These are all open-air localities and are primary to semi-primary in nature. These localities occur in clusters and the artefacts are found mostly on the surface. The locations of sites vary, with some situated on hilltops (for example Bijalpur Khurd, 339 m above msl), some along the foothills (for example Balwara village), while others cover vast forested areas. The distribution pattern and the contextual occurrence of the Acheulian localities discovered so far suggest the possibility of similar occurrences on the right bank of the Narmada. The site within the jurisdiction of the villages of Balwara and Bijalpur Khurd occurs in a stratified context and forms a substantial cultural deposit. The typo-technological features noticed in the assemblage suggest that the industry belongs to the Late Acheulian cultural phase. The assemblage comprises cleavers, handaxes, discoids, choppers, a variety of scrapers and a large number of simple utilized artefacts (Fig. 1). The locally available quartzite served as the principal source of lithic raw material. The

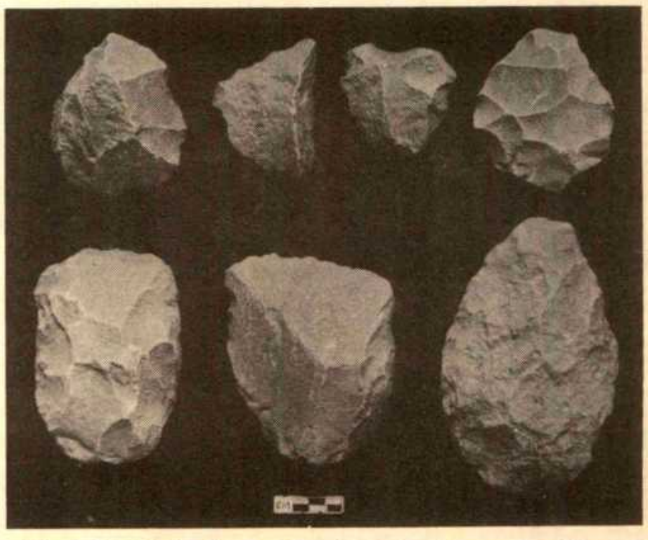

Fig. 1: Late Acheulian artefacts from the site near the village of Balwara and Bijalpur Khurd

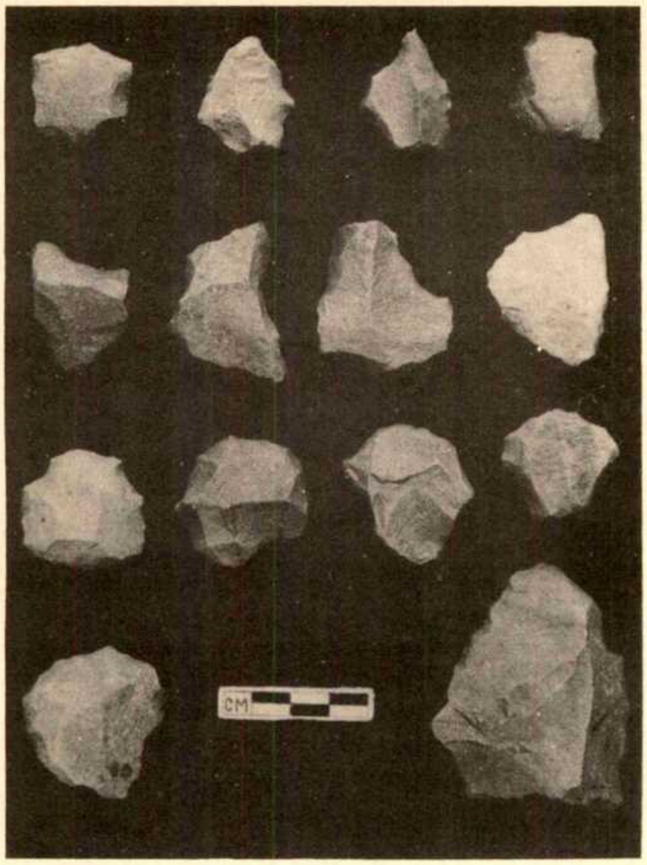

Fig. 2: A representative sample of Middle Palaeolithic artefacts from the Deccan Trap area, East Nimar District

most significant aspects of these localities are the differences in the size of the areas that they cover, the context of occurrence, variation in artefact density and variation in assemblage composition.

The Middle Palaeolithic sites are all surface occurrences and are located mostly in the Deccan Trap area which is characterized by rocky ridges and hillocks. The industry is characterized by a diminution in the size of artefacts compared with the preceding Acheulian industry and forms a distinctive assemblage (Fig. 2). The finished artefacts mostly comprise a variety of scrapers. Utilized flakes also occur in large numbers. Quartzite is the main raw material used in the manufacture of artefacts, although the locally available material, like chert, has also been utilized.

The area is rich in microlithic sites which mainly occur on the surface and close to perennial or seasonal streams. They are mostly confined to the undulating Deccan Trap region. The assemblages (Fig. 3), comprise finished artefacts such as points, lunates and backed blades, apart from a large number of simple artefacts. Blades and blade products occur rarely. Chalcedony is the major raw material while chert and other cryptocrystalline materials are present in smaller quantities.

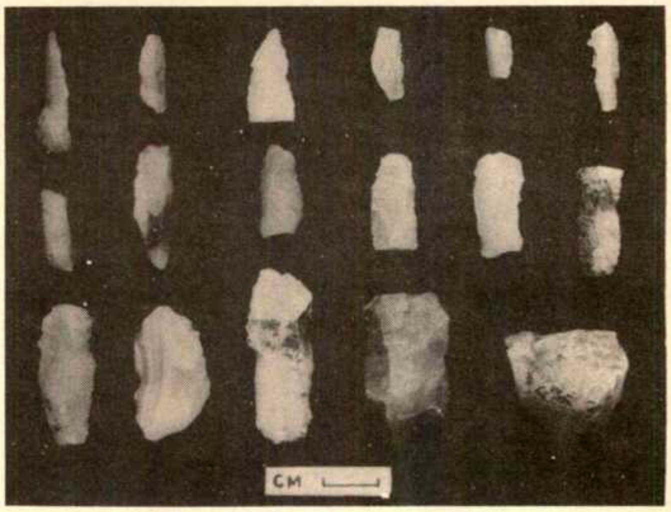

Fig. 3: Examples of Microliths from Deccan Trap area, East Nimar District

The most noteworthy feature observed around the villages of Gondikhera, Boribandri (Kherkheda), and Charkhera is that microliths, mostly of milky quartz, occur in association with some kind of structural remains, such as platforms, which probably formed the floors of huts. These platforms or floors are rectangular in shape, with rubble arranged along the periphery. None of these sites yielded any pot-sherds. However, pieces of broken bangle and copper objects belonging to the Historical period have been picked up from the structural remains at Boribandri (Kherkhada). The microliths and associated structural remains may be ascribed to communities contemporary with but less technologically advanced than those of the Historical period. However, further investigations are required in order to test this assumption.

Four Early Historical mounds have been located at the villages of Bijalpur Khurd, Purni, Newalkhera, and Chalpa Kalan. To ascertain the probable antiquity of these sites and of the associated cultural remains, a trial trench measuring 2.0 x 1.0 m was dug at the site of Bijalpur Khurd. A cultural deposit of a maximum thickness of about one metre was observed overlying the black soil. The ceramic industry of this period comprises Black-and-Red ware, Black Slipped ware, Black Polished ware, Plain Red ware and Red Slipped ware. Other antiquities belonging to this cultural period include a legged saddle quern, grinding stones, anvils, a burnisher, hop-scotch (a flat round stone/terracotta/pot-sherd used in a game played by children) and shell objects. Iron slag and corroded iron objects occur in all the occupational levels. A large number of animal bones, mostly of *Bos* sp., are common in all the levels. Successive lime plastered floors have also been encountered in the excavation. On the basis of a comparative study of the antiquities with the Early

Historical remains at Maheshwar and Navdatoli (Sankalia *et al.* 1958), the site at Bijalpur Khurd may be dated to about the 2nd-3rd century A.D.

As far as the medieval remains of the area are concerned, a large number of settlements in the form of mounds have been located in close proximity to the present-day villages. At some of these ancient sites rubble fortifications have been noticed. The significant aspect of these prolific archaeological remains in the area is that they might be said to corroborate the evidence for the occurrence of a severe famine during Shah Jahan's reign. This has been described by Abdul Hamid Lahori in the *Badshahnama*, a contemporary text of that period, describing the intensity of the calamity which desolated the Deccan, including the area under consideration. The high density of these settlements and their location in relation to the present-day settlements are suggestive of large-scale desertion at that time. This could be ascribed to the natural calamity mentioned above.

Of the medieval remains, mention may be made of a fortified site located on a hilltop near the village of Bijalpur Kalan and locally known as 'Kotra'. The fortification is of undressed rubble and mud and follows the contours of the hill. This fortification encompasses an elaborate, well-planned settlement with lanes that cut across each other at right angles. A cemetery area and a rain-fed tank with a bund on one side have been located on the south and east respectively, of this settlement. Antiquities collected from the site include a brick on which the outline of a game board has been engraved, and stone objects like saddle querns, grinding stones, stone potter's wheels, and stone lamps. The metal objects found at the site are represented by an iron nail, a bangle and a copper ring. Cowries, glass bangles and beads of both lac and stone have also been collected.

A large number of remains of temples have been brought to light during the course of the investigation. On the basis of architectural style, material used and sculptural remains therein these remains can be tentatively divided into three successive phases of construction. The temples belonging to the earliest phase are all brick constructions such as the Barkeshwar temple at Balri (observation made during excavation carried out by the Excavation Branch, Nagpur in 1988) and the temple at Susarel. The second phase of temple construction is characterized by stone with elaborate carvings and fine sculptural remains as observed at Barkeshwar temple (Fig. 4) (Vyas 1989: 167-168), and at the shrines in Chandel, Jogibida, Kukdal, Bijalpur Kalan and Harsud. On the basis of iconographic features and architectural styles, the temples belonging to this phase can be ascribed to the 12th-13th century A.D. Temples of the third phase are made of brick as well as of stone, for example the ones at Khudia (Mal) (Fig. 5), Torniya, Bhawarli, etc. These are all plain constructions without any carvings, and they belong to Late Medieval times. Almost all these temples are in a poor state of preservation and have been robbed of many of their architectural components.

Of the loose sculptures noticed in the area, mention may be made of images of Vishnu at Bhilgarh in village Jamoti, and at Kukdal, and Newalkhera, in addition to statues of Ganesa at Bijalpur Khurd, Panghat (Kalan) and Jogibida. The temple at Jogibida has a number of magnificent sculptures of Ganesha, Siva, Narasimha, Brahmani, Vaishnavi, Maheswari, Kaumari, Indrani and Chamunda. The Saraswati *kund* at Harsud contains two beautiful images of Vishnu which have been fitted into the brick wall of the *kund* (Shah 1979: 67-69). On the basis of iconographic and stylistic features, these icons can be dated to c. 12th/13th century A.D. A Devanagari inscription, probably of 13th/14th century A.D., has been noticed in a modern shrine at Panghat (Kalan). Images of Hanuman in bas relief are among the sculptures that are commonly associated with these medieval sites.

A number of tombs, houses, wells and some unidentified structures belonging to Late Medieval times have been noticed in the area. These structures are constructed of dressed stones or *lakhauri* bricks, and lime has been used as mortar.

A number of iron smelting localities, both with and without habitational debris, have been located. These localities, represented by heaps of iron slag, occur in isolation as well as in clusters. At certain localities, smelting

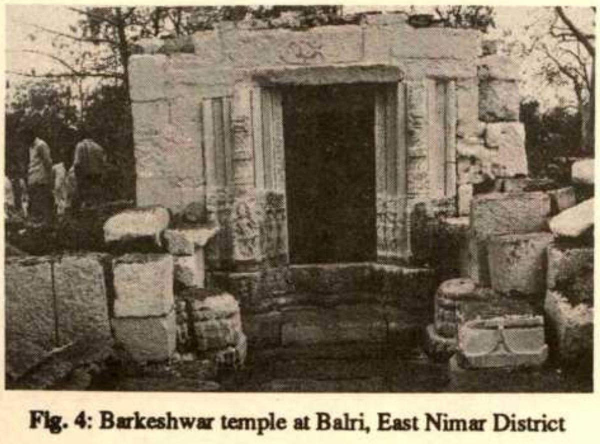

Fig. 4: Barkeshwar temple at Balri, East Nimar District

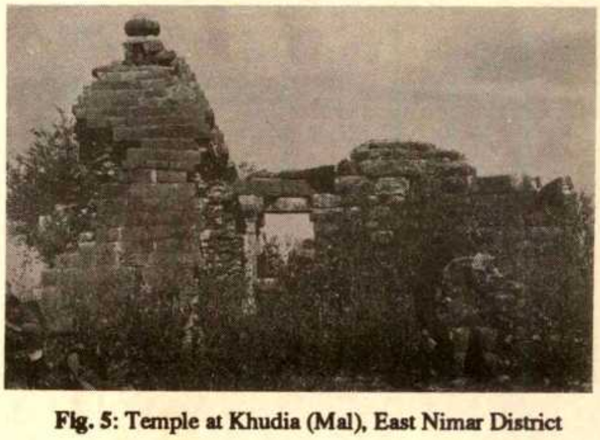

Fig. 5: Temple at Khudia (Mal), East Nimar District

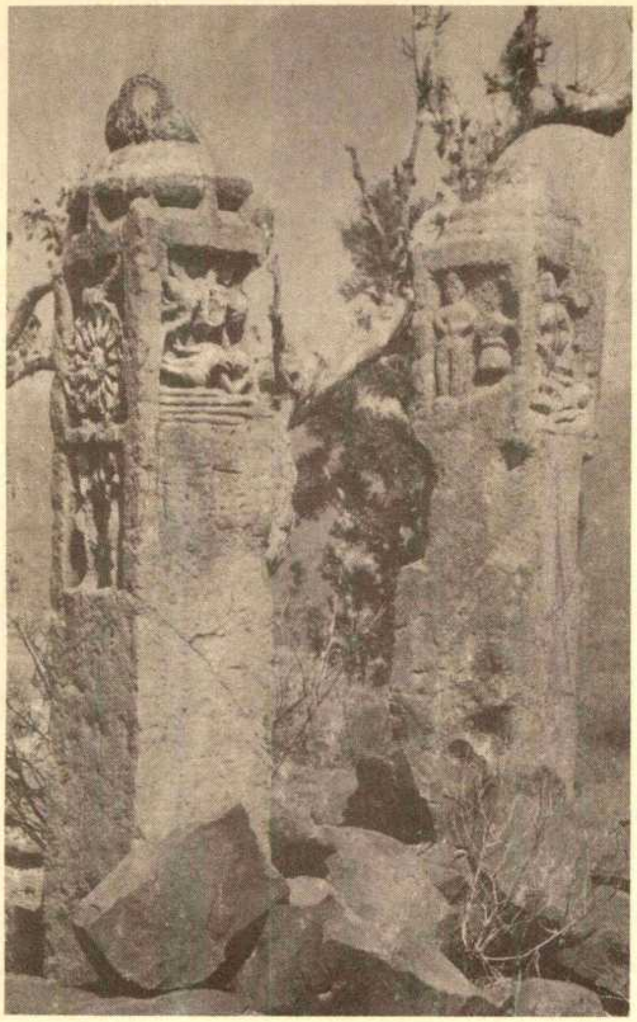

Fig. 6: *Sati* memorial stones at the village Bijalpur Khurd, East Nimar District

furnaces have been noticed in association with the slag heaps. All these sites are mostly confined to the Vindhyans where iron-ore deposits have been located. Due to lack of further information, it is difficult to determine the antiquity of iron smelting activity in the area. However, as suggested by evidence from the Early Historic site at Bijalpur Khurd, it may be tentatively dated to the early centuries of the Christian era.

Memorial stones, square in plan, have been found standing upright at Bijalpur Khurd (Fig. 6), Nagpur and Jogibida. Figures of horse-riders, the sun, the moon, *sati*, etc. suggest that these are *sati* memorial pillars. One of the memorial stones at Bijalpur Khurd contains an inscription in Devanagari.

Recommendations

In spite of this survey being a preliminary one, it has revealed that the area to be submerged under the Narmada Sagar Project has great archaeological potential. Based on the present survey, the following recommendations have been made in order to facilitate multidisciplinary research and salvage operations to be undertaken in future.

(a) An intensive survey to document all the archaeological sites.

(b) Since the present area has great scope for prehistoric research, it is suggested that a long-term plan for investigations, including excavation must be undertaken to elucidate the geoarchaeology of the area.

(c) Excavations of both Early Historic and Medieval sites are strongly recommended in order to ascertain the cultural succession of the area both in terms of time and space. It is also essential to carry out some horizontal excavations at selected sites belonging to different cultural periods in order to understand the subsistence-settlement patterns, social organization, demography and patterns of land-use.

(d) The relocation of the temples located within the jurisdiction of the village of Balri, Chandel, and Jogibida must be undertaken, in addition to the excavation and documentation of certain other temples and structural remains.

(e) Some of the iron smelting sites should be excavated and studied scientifically in order to gain further insight into the ancient technique of producing iron in this area.

(f) Loose sculptures and memorial stones may be shifted to the local museums.

The Attitude of Archaeologists to our Cultural Heritage

An overall view of government policies and the attitude of archaeologists to the destruction of our archaeological heritage due to the rapid modification of the landscape is quite disheartening. Neither the government nor non-government archaeological organisations are paying any serious attention to the fate of our heritage in spite of knowing fully well the extent and rate of destruction that has taken place during recent years. Every year new projects for archaeological research are taken up by various organisations, mostly in the areas where archaeological sites are not in danger of being destroyed. Instead the urgency of salvage operations should be stressed, especially in areas where our archaeological heritage is being threatened. Unfortunately wherever any salvage operation is undertaken, priority is given to the standing structural remains rather than to prehistoric sites, mounds, etc. This clearly suggests that we are more concerned with protecting structures than with gaining a wider knowledge of our past. We prefer to relocate the structural remains but do not care to preserve buried and surface archaeological sites which are less impressive but equally or more important for providing information about our earliest cultures.

Finally, it may not be out of place to quote an extract from the 'draft universal declaration on indigenous rights' prepared by the Working Group on Indigenous Populations which states, "The right to preserve their cultural identity and traditions and to pursue their own cultural development... the right to the manifestations of their cultures, including archaeological sites, artifacts, designs, technology, and works of art, lie with the indigenous peoples or their members" (Alfredsson 1989: 258).

Acknowledgment

I am grateful to my colleagues, N.G. Nikoshey, N. Taher, J.S. Dubey, R.K. Dwivedi, N.K. Nimje, C.L. Yadav and P.S. Pashine, for their co-operation during our investigations. I am also grateful to the people of the study area who were not only extremely helpful but also showed a keen interest in learning about their cultural heritage.

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Indian Society for Prehistoric and Quaternary Studies

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Report of the General Secretary for 1991-92 (1.4.91 to 31.3.92)

The current year has continued to be very fruitful for the Society. Once again we gratefully acknowledge not only the major grant given by the Ford Foundation, New Delhi, but also the valuable and continuing support of the Archaeological Survey of India, New Delhi and the Indian Council of Historical Research, New Delhi.

Man and Environment

The Journal, in the third year of its bi-annual series, has been commended for its quality and timely publication.

The June 1991 issue carried the Presidential Address of Prof. K.T.M. Hegde on *Ancient Indian Iron Metallurgy*, as well as the First Professor H.D. Sankalia Memorial Lecture. Both these were presented at the Society's XVIII Annual Conference held at Kanyakumari. The Memorial Lecture was delivered by Prof. B.B. Lal. The title, *Planned Cooperation Between Archaeologists and Scholars of Ancient Literature — A Crying Need* invited attention to "... an in-depth study of literary texts on the one hand and equally thorough re-examination of archaeological data on the other".

This issue carried papers on various aspects of prehistory, among them the one by Asok Datta on blade tools from a part of West Bengal and that by P.P. Joglekar and others on issues pertaining to the metrical study of stone tools. The report of a seal from Rangpur by R. Bhattacharyya has revived the interest of archaeologists to re-open the study of this site. The preliminary archaeological investigations by D.P. Agrawal (senior author) in the Kumaon Himalaya calls for detailed multi-disciplinary research in this region. The botanical studies included papers by Chhaya Sharma and M.S. Chauhan on the Western Indian Plains, by N. Seetha Reddy on an important Harappan site, Oriyo Timbo and by P.C. Venkatasubbaiah and M.D. Kajale on Neolithic and Early Historic sites in Cuddapah District. A study on human skeletal remains from a Megalithic site in Cuddapah District by S.R. Walimbe and others forms a part of the bio-archaeological section of the Journal.

Reports of important International Conferences attended by members and executives of the Society were published in the June and December issues of the Journal.

The second issue (Volume XVI, No. 2, December 1991) carried a number of articles on prehistoric paintings. The article by M. Lorblanchet, *From the Cave Art of the Reindeer Hunters to the Rock Art of the Kangaroo Hunters* is an updated and expanded version of the article originally published in *L'Anthropologie*. E. Neumayer presents a detailed account of the animals depicted in paintings from the prehistoric to the historic period wherever carts, chariots and mounts are depicted. The rock art in the Pachmarhi Hills depicting head-hunting scenes is discussed in Ms. Dubey's article. N. Chandarmouli describes the rock paintings from Budagavi and V.Shinde reports the discovery of a painting of a horn-headed human figure on a very large pot from Padri and described by him as *Pasupati*. Dennell and Rendell in their article have re-examined the work of De Terra and Paterson in the Soan Valley and re-interpreted the data in the light of their field studies. Investigations on Mesolithic cultures from southern Scandinavia (T.D. Price) provide a better understanding of this culture. The article on the ancestry of *Bos* species is the third in a series by P.P. Joglekar and P.K. Thomas. M.D. Kajale and others have reported their findings on wood remains from the Kurnool Caves.

We would like to acknowledge the sincere efforts of Mr. Sujit Patwardhan and his staff at Mudra for their excellent cooperation in the production of this Journal.

Annual Conference

The XIXth Annual Conference of the Society was held at Bhopal between 16-18 December 1991, jointly with the annual conferences of the Indian Archaeological Society (I.A.S.) and the Indian History and Culture Society (I.H.C.S.). The three societies were invited last year by the Commissioner of Archaeology and Museums, Government of Madhya Pradesh to hold their joint Conference at Bhopal.

The I.S.P.Q.S is grateful to Mr.K.K. Chakravarty, former Commissioner of State Archaeology and Museums, Bhopal, Dr. Ajit Raijada, Commissioner of State Archaeology and Museums, Bhopal and Dr. O.P. Mishra, Publication Officer of State Archaeology and Museums for their sincere efforts and cooperation to make the Conference a success.

The Conference was attended by over 150 delegates which included veteran archaeologists, historians, professors and students from all over India. The joint conference provided a platform for academic dialogue between various people interested in the fields of archaeology, history, culture and Quaternary geology. The Conference of the Indian Society for Prehistoric and Quaternary Studies focussed on "Prehistoric Rock Art" and comprised a Seminar and an Open session.

The Conference was inaugurated on 16th December at 10.00 a.m. by His Excellency Kunvar Mahamud Ali Khan, Governor of Madhya Pradesh. The Honorable Minister of Culture Mr. Kailash Chavala, presided over the function. Dr. Ajit Raijada, Commissioner of Archaeology and Museums gave the vote of thanks. The academic sessions began after the inaugural function.

On 17th December 1991, the academic sessions of the three societies continued till late afternoon. At 5.00 p.m. Mr. M.N. Deshpande delivered the 2nd Professor H.D. Sankalia Memorial Lecture. At 7.00 p.m., the first Wakankar Archaeology Award was conferred on Prof. B.B. Lal by the Honorable Chief Minister of Madhya Pradesh Mr. Sundarlal Patwa. The function was presided over by the Honorable Minister of Higher Education Mr. Vikram Verma.

The third day began with a continuation of the academic sessions. In the pre-lunch session, the first H.D. Sankalia Young Archaeologist Award was conferred on Miss Rajam Seshadri from M.S. University of Baroda, who presented at the Conference her research paper *The Composition and Smithery Techniques of Copper Artefacts from Nagwada — A Preliminary Study*. The panel of judges included Mr. M.N. Deshpande, Prof. Soundara Rajan and Prof. S.N. Rajaguru.

The valedictory function was held in the hall of the Academy of Public Administration on 18th December at 3.00 p.m. Shri Krishna Lal Verma, the Honorable Minister for School Education was the chief guest and Shri Prem Prakash Pande, the Honorable Minister for Higher Education chaired the function.

Life Members

There has been a considerable addition to the list of life members. In the current year (upto 31.3.1992) the following life members have been welcomed to the Society:

(1) Ms. Rajani G. Arora (2) Mr. P.P. Dandawate (3) Dr. Hema Achyuthan (4) Ms. Arati Deshpande (5) Mr. Murari Lal Sharma (6) Mr. Shrikant S. Jadhav (7) Mr. K.C. Srivastava (8) Dr. M. Kasturi Bai (9) Mr. Jeevan Kharakwal (10) Ms. Seema J. Pawankar (11) Ms. Veena Rao (12) Mr. N. Tahir (13) Mr. Manabu Koiso (14) Mr. B.K. Thapar (15) Dr. S.K. Tandon (16) Mr. Piyush Bhatt (17) Dr. T.R. Sharma (18) Mr. Atul Kumar Verma (19) Mr. Suchindra Mukherjee (20) Dr. Vijay Singh (21) Mr. S. Murali Mohan (22) Dr. Nirdip Roy (23) Mr. B.L. Nagarch (24) Mr. Vinod Seth (25) Ms. Bhamini Mahida (26) Dr. R.C. Agarwal (27) Mr. J.P. Joshi (28) Mr. Ramesh Chander (29) Mr. Sila Tripathi (30) Mr. S.S. Kulkarni (31) Dr. S.S. Merh (32) Mr. Ajay Mitra Shastri (33) Mr. R.M.M. Chandraratne (34) Ms. Katheleen Ryan

Thus, the total number of life members now is 266.

This year we note with regret the sad demise of two of our esteemed life members, Dr. Vishnu-Mittre and Prof. Gurdip Singh.

Annual Members 1991

1. Mr. Rahul Sen 2. Mr. Ajay Pratap 3. Mr. Puroshattam Sharma 4. Mr. S.N. Bajapai 5. Mr. Vinod Nautiyal 6. Mr. N.P. Choudhari 7. Mr. S.K. Rao, are new additions to our annual members list.

Meetings of the Executive Committee

(A) An emergency meeting of the Executive Committee of the Indian Society for Prehistoric & Quaternary Studies was held at 3.00 p.m.on Wednesday 18th September 1991 in the Society's office in the Department of Archaeology, Deccan College, Pune, to consider the proposal of Prof. V.N. Misra that the Society, jointly with the Indian Archaeological Society should come forward to organise the Third Session of the World Archaeological Congress (WAC) in India in 1994, in the event that the Archaeological Survey of India was unable to do so.

The members present were: 1. Prof. V.N. Misra 2. Prof. S.N. Rajaguru 3. Dr. P.K. Thomas 4. Dr. Statira Wadia 5. Dr. Zarine Cooper 6. Dr. R.K. Ganjoo 7. Mr. P.P. Joglekar

Prof. V.N. Misra, Vice-Chairman of the Society presided over the meeting. The proposal was discussed at length and it was decided that given the financial and organisational implications of holding the Congress, it would not be possible for the Society to make any commitment until the role of other potential organising institutions and funding sources were clarified.

Finally the Committee passed the following Resolution:

> "Resolved that in case the Archaeological Survey of India is not in a position to invite the World Archaeological Congress to hold its next session (WAC III) in

India in 1994, the Indian Society for Prehistoric and Quaternary Studies, jointly with the Indian Archaeological Society, should step in and extend a formal invitation to hold the session in India, and initiate immediate necessary action in the matter".

The Committee authorised Prof. V.N. Misra to discuss, jointly with the representatives of the Indian Archaeological Society, the various implications of organising the Congress with the WAC Executive Committee which was meeting in London towards the end of September 1991, and to report back the substance of the discussion and decisions, if any, to the Executive Committee of the Indian Society for Prehistoric and Quaternary Studies on his return.

The Committee also authorised Prof. V.N. Misra to extend, jointly with the Indian Archaeological Society, a provisional invitation to the WAC Executive Committee to hold the Congress in India.

(B) The meeting of the Executive Committee of the Indian Society for Prehistoric and Quaternary Studies was held at 12.30 p.m. on 30th October 1991 in the Society's office in the Department of Archaeology, Deccan College, Pune.

The following members were present: 1. Prof. V.N. Misra 2. Prof. S.N. Rajaguru 3. Dr. P.K. Thomas 4. Dr. Statira Wadia 5. Dr. Zarine Cooper 6. Dr. Ravi Korisetter 7. Dr. R.K. Ganjoo 8. Mr. P.P. Joglekar

Prof. S.N. Rajaguru, General Secretary of the Society presided over the meeting.

The following items on the agenda were discussed and resolved:

(1) Increase the price of the journal *Man and Environment* from Rs. 200 to Rs. 300 per issue w.e.f. 1-1-1992 and the price in foreign currency (U.S. Dollar) not to be quoted and printed in the Journal.

(2) Increase in the subscription of life membership to Rs. 800 from 1-1-1992 payable in a maximum of three installments spread over 12 months from the date of payment of the first installment.

(3) Increase in the honorarium of Mr. V.S. Gavade and Mr. S. Amin to Rs. 300 and Mr. C.S. Shendge to Rs. 200 per six months from 1-1-1992 for secretarial assistance.

(4) Purchase of two steel cupboards for storage of the journal.

(5) Purchase of a PC-AT 286 for secretarial and editorial work of the journal *Man and Environment*.

(6) Acceptance of the resignation of Dr. R.K. Ganjoo from the post of Joint Secretary of the Society.

(7) Discontinuation of the practice of posting the Journal to life members who have not paid the balance of their membership subscription.

(C) The meeting of the Executive Committee of the Indian Society for Prehistoric and Quaternary Studies was held at 8.30 p.m. on 17th December 1991 in the Maulana Azad College of Technology, Bhopal.

The following members were present: 1. Prof. V.N. Misra 2. Prof. S.N. Rajaguru 3. Dr. R.K. Ganjoo 4. Dr. Ravi Korisetter 5. Mr. P.P. Joglekar

Prof. V.N. Misra, Vice-Chairman of the Society presided over the meeting.

(a) It was decided to invite Prof. Soundara Rajan to deliver the 3rd Prof. H.D. Sankalia Memorial Lecture at the XX Annual Conference of the Society to be held in 1992.

(b) It was unanimously agreed to elect Prof. D.P. Agarwal as the President of the Society for the year 1992.

(c) Prof. S.N. Rajaguru, General Secretary presented his report for the year 1990-1991 and members discussed various points related to the functioning of the Society and arrangements for the annual conferences so that these could be held in a more efficient manner.

Appointments to International Bodies of Research

It is a great honour for the Society that Dr. S.N. Rajaguru, General Secretary, ISPQUS has been nominated a member of the IGBP (International Geosphere-Biosphere Programme) Committee on Asia's Palaeoenvironment and Dr. Ravi Korisettar, Associate Editor has been nominated a member of the INQUA (International Union for Quaternary Research) Commission on Tephrochronology.

Date: 1.6.1992

S.N. Rajaguru
General Secretary

INDIAN SOCIETY FOR PREHISTORIC AND QUATERNARY STUDIES

c/o Department of Archaeology, Deccan College, Pune 411 006

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED ON 31.03.1992

EXPENDITURE	AMOUNT		INCOME	AMOUNT	
Establishment Expenses			Bank Interest	3,540.02	
			Accured Interest	55,376.60	58,916.62
Stationary (A/c. No. 2107)	326.30		(not received)		
Stationary (A/c. No. 717)	5,593.80				
Bank Commission	503.00		Grants		
Honorarium	1,500.00		ICHR for Conference	7,500.00	
Postage	3,967.65		Grant for M&E (ASI)	15,000.00	
Advance Tax	122.00		Grant ICHR	14,250.00	36,750.00
Publication of M and E	516.30				
Xerox	18.40		Other Income		
Petrol	793.90		Life membership fee	17,145.00	
Misc. Exps.	293.25		Cost of Reprints	510.00	
Telephone	185.40		Royalty	11,104.00	28,759.00
Tea	59.20	13,879.20			
Depreciation on					
Furniture	7,468.55				
Computer printer	2,222.28	9,690.83			
Expenditure on object of the Trust					
Publication of M and E					
Printing	68,684.00				
Stationary	4,040.00				
Typing	200.00	72,924.00			
Conference Expenses (Ac. No. 717)					
Printing and Stationary	880.00				
Travelling & Incidental charges	6,598.00				
Rent	239.45	7,117.45			
Audit Fees		2,350.00			
Surplus Transferred to Balance Sheet		17,854.34			
		1,24,425.62			1,24,425.62

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(P.P. Joglekar)
Assistant Secretary

(P.K. Thomas)
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INDIAN SOCIETY FOR PREHISTORIC AND QUATERNARY STUDIES

c/o Department of Archaeology, Deccan College, Pune 411 006

BALANCE SHEET AS AT 31st MARCH 1992

LIABILITIES		Rs. Ps.	ASSETS		Rs. Ps.
Other Earmarked Funds (Grant from Ford Foundation for Publication of M and E)		6,06,108.10	Investments F.D.R. with Central Bank of India		5,87,000.00
Liabilities for Expenses		2,350.00	Furniture and Fixtures		68,795.38
Provision for Contribution		593.94	Computer Printer		6,666.83
Income and Expenditure Account			Income Outstanding		
As per last balance sheet	1,68,372.66		Accrued Interest on F.D.R.		29,688.83
Add: surplus	17,864.34	1,86,237.00			
			Cash and Bank Balances		
			Bank A/C No. 717	63,465.85	
			Bank A/C No. 2107	39,961.90	
			Stamps in hand	147.60	
			Cash in hand	1,552.65	1,05,128.00
		7,97,289.04			7,97,289.04

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Man and Environment

Editors	V.N. Misra Sushma Wagle	Associate Editors	Ravi Korisettar Zarine Cooper P.P. Joglekar

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Man and Environment is published biannually in June and December. It publishes original research papers, review articles, short communications and book reviews. The scope of the Journal encompasses human societies and all aspects of their environment, as well as contemporary societies which have a relevance to the past.

Contributions to the Journal should be sent to V.N. Misra c/o Department of Archaeology, Deccan College, Pune 411 006, India. The parcel containing the manuscripts should be superscribed "For Man and Environment". The authors are requested to follow the Guidelines for Contributors printed in *Man and Environment*, Volume XIII. They can also ask for a copy of the Guidelines from the Editor. Manuscripts and floppy disks must be sent by Registered A.D.

All articles submitted for publication will be refereed. Authors will be asked to revise their manuscripts in the light of referees' comments. Acceptance of the manuscripts will mainly depend on the approval of the referees.

Authors will get 25 reprints of their papers free. They can order additional reprints at cost price, information about which will be sent to them along with the galley proofs of their manuscript.

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Publisher: Indian Society for Prehistoric and Quaternary Studies
c/o Department of Archaeology, Deccan College,
Pune 411 006, India

Printer: Mudra
383 Narayan Peth
Pune 411 030

Distributors: Books & Books
C4/A/20 A, Janakpuri
New Delhi 110 058

Price: Rs. 250.00

Man
and
Environment

Journal of the
Indian Society for
Prehistoric and Quaternary Studies

Volume XVII, Number 2 (July - December), 1992

Indian Society for Prehistoric and Quaternary Studies

c/o Department of Archaeology
Deccan College Post-Graduate and Research Institute
Pune 411 006, India

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Change of address should be immediately communicated to the General Secretary to ensure prompt despatch and safe delivery of the Journal, conference circulars, etc.

Editorial

It has been the convention from the inception of the Journal in 1977 that its release should coincide with the Annual Conference of the Society which usually takes place at the end of December. After the Journal became biannual in 1989, the second issue of the Journal has been released at the time of the Conference. This year the date of the Conference has been advanced by almost two months which leaves us much less time than usual to edit and print the Journal. We are nevertheless trying our best to see that this issue of the Journal is published in time without affecting its quality.

As in previous issues, once again we have a broad range of papers covering the period from the Pleistocene to the present, and a variety of themes ranging from the Quaternary environment to the ethnoarchaeology of late Holocene hunter-gatherers. The majority of the papers, however, centre around the theme of bioarchaeology, covering both animal and human populations.

Readers of the Journal will recall Professor B.B. Lal's proposal, in his Presidential Address, in the last issue, for the publication of a series of popular books on Indian archaeology.

The Executive Committee of the Society has endorsed Professor Lal's proposal, but is of the view that the Society's resources will not permit the publication of all the fifty titles suggested by Professor Lal. Therefore the Society has proposed that it should undertake the publication of titles in Prehistory and Protohistory, and responsibility for publishing titles in historical archaeology should be assumed by the Indian Archaeological Society. Members are requested to send us their suggestions regarding the titles and prospective authors.

While it is not the Society's policy to undertake the publication of the papers presented at its Annual Conference, the editors would nevertheless like to consider individual papers for publication in the Journal. Authors who would like to offer their papers to the Journal are requested to bring two copies of their manuscripts prepared according to the Journal's guidelines and hand them over to the editors present at the Conference.

Two years ago the Society instituted the H.D. Sankalia Young Archaeologist Award with a view to encouraging good quality research by young archaeologists. We regret, however, that the response so far has been rather poor. We are aware that research of a high standard is being conducted by eligible scholars at different institutions in the country. We appeal to them to come forward with their contributions for this award at the time of the Society's Annual Conference.

The World Archaeological Congress 3 (WAC 3) will be held in New Delhi from 4 to 11 December, 1994. The First Announcement of the Congress has already been issued in July and circulated widely to archaeologists all over the world. Members who may not have received the Announcement but who would like to participate in the Congress are advised to contact Dr. Makkhan Lal (P.O. Box 112, H.P.O., Aligarh 202001, India, Phones: (571) 29143 and (571) 25546; Telex: 564-230-AMU-IN) for WAC membership and suggestions regarding academic programme, and Mr. M.C. Joshi, Secretary General of the Congress (Director General, Archaeological Survey of India, Janpath, New Delhi 110011, India, Phones: (11) 3014821 and (11) 3012058; Telex: 031-66242 ASI-IN; Fax: (91) (11) 3019821) for all matters relating to the Congress. They are also requested to bring this information to the notice of other colleagues.

During the last eleven months Indian archaeology has lost six eminent scholars — Professor Vishnu-Mittre and Professor Gurdip Singh (November 1991), Professor George F. Dales (April 1992), Professor K.D. Bajpai (June 1992), Professor K.K. Sinha (July 1992) and Professor K.T.M. Hegde (September 1992). Each of these scholars has made a significant contribution in his chosen field. The Society mourns the passing away of these scholars. We hope to carry their obituaries in the forthcoming issues of the Journal.

Influence of the Philosophy of Sankaracharya on Hindu Temple Architecture and Symbolism*

M.N. Deshpande

Former Director-General
Archaeological Survey of India

This lecture is dedicated to the memory of my illustrious teacher, the late Professor H.D. Sankalia, who inculcated in his pupils the spirit of inquiry and of constant search for 'Truth'. This tribute is a humble attempt to discover and comprehend the deeper significance lying concealed behind the hard and impenetrable exterior of the Kailāsa temple, which is carved out of volcanic rock. This temple is a *Jotir-linga*, the effulgent column of fire and 'knowledge' incarnate.

The eighth and a part of the following century of the Christian era were influenced by the unique personality of Bhagavadpāda Śaṇkara (A.D. 788-820).[1] Although his lifespan was very brief, he dominated the intellectual and religio-philosophical world of his time and the centuries to follow like a colossus. *Advaita* (non-duality) was the hallmark of his teaching and, according to him, the 'Unqualified Absolute' (*nirguṇa Brahman*) as the ultimate reality could be realised through knowledge alone, *karma* and *upasana* being subsidiary (*Kevalādeva jñānāt mokṣa-prāptiḥ na karma sasmuccitāt*).

His commentaries on the *Vedānta-Sūtras*, the principal *Upaniṣadas* and the *Bhagvadgita*, and his original works like the *Upadeśasāhasri* and *Vivekachūdāmaṇi*, his innumerable poems, hymns and prayers mark him out as one of the greatest interpreters of *Vedānta*. It would not be an exaggeration to say that Śaṇkara took the contemporary philosophical world by storm with his penetrative wisdom, moral fortitude, literary grace and above all by his mystical insight which saw harmony and symmetry everywhere. He visualised real unity in the midst of apparent diversity, and he went on converting teacher after teacher, to his point of view, like a *Chakravartin* subduing one ruler after another.

As an archaeologist and art-historian and one interested in religious and philosophical movements, I began to scan the Indian monumental landscape in order to discover and identify the edifices of the eighth and ninth centuries which would perhaps bear the impress of Śaṇkara's philosophy. While studying the symbolism of the great Rashtrakuta monolith, the Kailāsa temple at Ellora[2] (Fig. 1 and 2), I felt that I had the first glimpse of the impact of Śaṇkara's philosophy of *Advaita* (monism) in this great temple. The first ray of light came from a couplet by Jnanesvara, the poet-saint of Maharashtra, in his philosophical work *Amritānubhava*. This is one of the greatest philosophical works in Marathi literature, in which the couplet describing the nature of *Advaita-bhakti* occurs as follows: *Deva deūḷa parivāru kīje korunī doṅgaru. Taisā bhaktīcā vyavahāru kā na vhāvā. Amritānubhava,*[3] (9-43).

In his explanation of *Advaita-bhakti*, as expounded by Jnanesvara and with particular reference to the verse quoted above, Professor R.D. Ranade (1988: 164) states:

> "In Supreme Devotion, therefore, the devotee has nothing but God even for his material or worship. Here it may be said that God worships God. And Jnanesvara does not think this to be impossible, for he tells us that from the same rock are carved the idol of God, the temple, and God's attendants, which seem to be different, and are yet one."

This reference to the carving of the rock and fashioning out of it the God (*Deva*), his tabernacle (*deūḷa*) and his attendants (*parivāra*) is unmistakably to the Kailāsa temple. It is said that Jnanesvara once travelled from Alandi to

---

* The second Professor H.D. Sankalia Memorial Lecture delivered under the auspices of the Indian Society for Prehistoric and Quaternary Studies at the XIXth Annual Conference of the Society held at Bhopal from 16-18 December 1991.

[1] The date of Śaṇkaracharya is still a matter of controversy among scholars, many of whom tend to place him about a century earlier than the accepted date mentioned above. A summary of the views regarding the date of Śaṇkaracharya are available in Swami Prabhavanada's *Spiritual Heritage of India*. Even granting that he lived a century earlier than the generally accepted date, the main thesis presented in this paper would not be affected.

[2] The author has discussed the symbolism of Kailāsa in an article on this subject (Deshpande 1988).

[3] This verse, referring to Kailāsa (Ranade 1969:8) was mentioned by me in my Marathi article published in the special Diwali issue of *Marathwada* (1958) from Aurangabad.

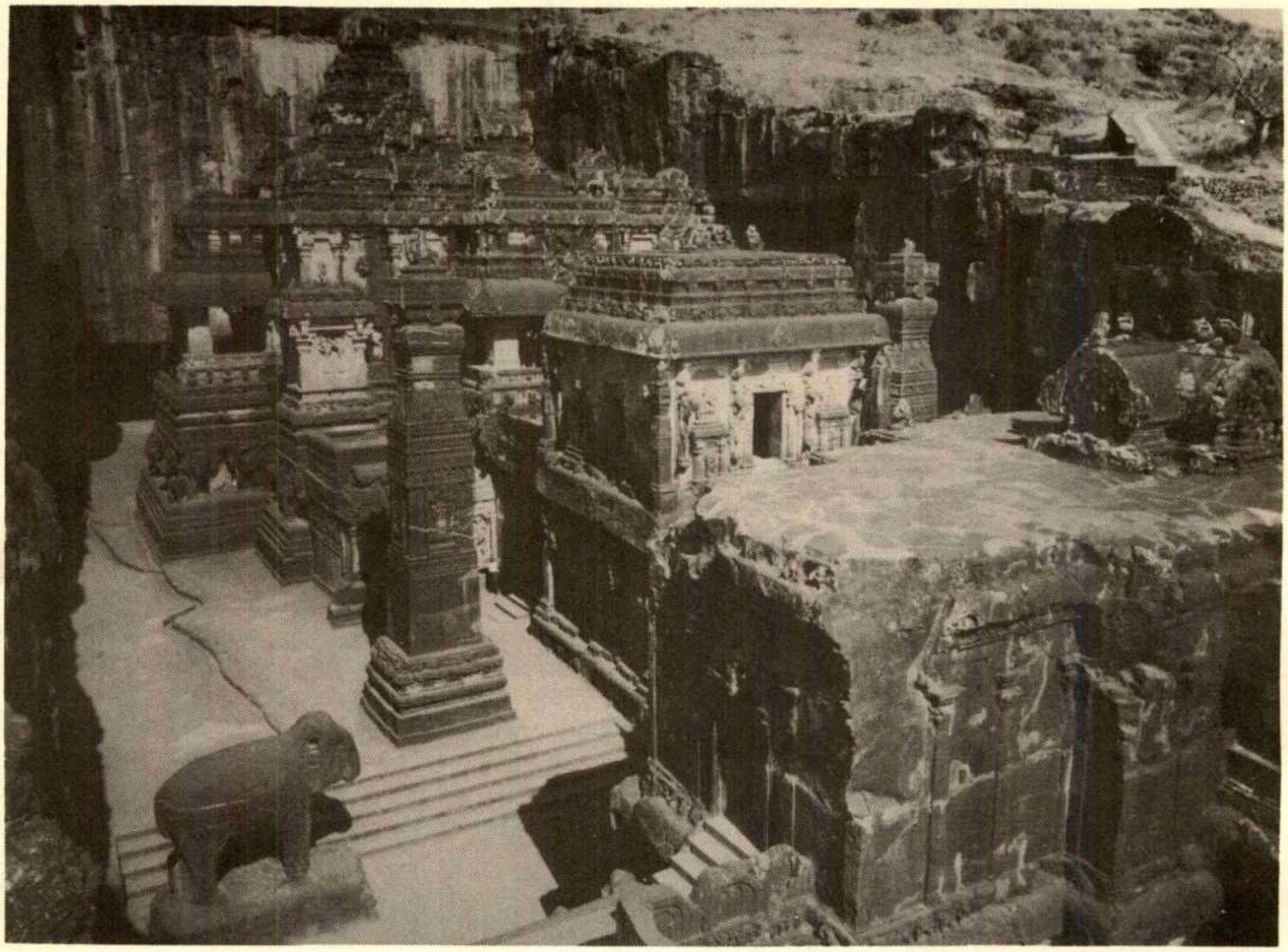

Fig. 1: General view of the Kailāsa monolith

Paithan,[4] and, while passing Ellora, he saw the grand temple of Siva. He has couched this sublime vision in words of unsurpassable beauty in the couplet already referred to.

Carving out such a monolith was not an isolated effort or limited to one region. At Dhamnar, in the district of Mandsaur, Madhya Pradesh, there is a monolithic temple dedicated to the four-armed manifestation of Viṣnu called Dharmanatha (Fig. 3). It has been constructed in the *nāgara* or Indo-Aryan style which was prevalent in North India, and which belongs to almost the same period as that of the Kailāsa temple at Ellora. The temple at Dhamnar, which faces east, is surrounded by seven rock-cut shrines, four located in the four corners of the pit, and the remaining three facing the three *bhadra* niches of the *garbha-griha* in the cardinal directions. The temple consists of a *garbha-griha*, *antarāḷa*, *maṇḍapa* and *mukhamaṇḍapa*. The entire temple is *pañcharatha* in plan and elevation, and represents all the components of the early medieval temples (Trivedi 1981).

Yet another temple of this variety, called Chaturbhuja, stands in the fort at Gwalior (*Gopādri*) in Madhya Pradesh (Fig. 4 and 5). It has been carved out of the sandstone hill. It is also in the northern or *nāgara* style and has all the features of the Pratihara period temples. In plan it is *pañcharatha*, but it is asymmetrical because the sculptors had to work under the constraints imposed by the limited space available on the detached rock. The monolithic temple faces east and consists of a *garbha-griha* and *mukhamaṇḍapa* with a *śikhara* preserved in the monolithic rock-cut form up to three *bhūmis*. The upper part of the structure is presently undergoing restoration with plain blocks of ashler masonry to which crowning members are being added.

The temple bears two inscriptions, one engraved above the doorway and the other inside the *garbha-griha*. The former informs us that the temple is dedicated to Visnu (*Viṣnoridam mañḍiram*) and was built by Alla, the son of Vaillabhatta. The temple is monolithic and is termed as *ekaśila* and *tankotkirṇa* (cut by means of the chisel). The

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[4] Paithan, Aurangabad District, was well known as Pratisthana, the capital of the Satavahanas. It continued to be a great centre of Brahmanical learning where Jnanesvara went to meet the *pandits* and seek their verdict on the question of his belonging to the Brahmin caste, as he was born after his father had abjured *sanyāsa* and become a *grhasta* and lived with his wife.

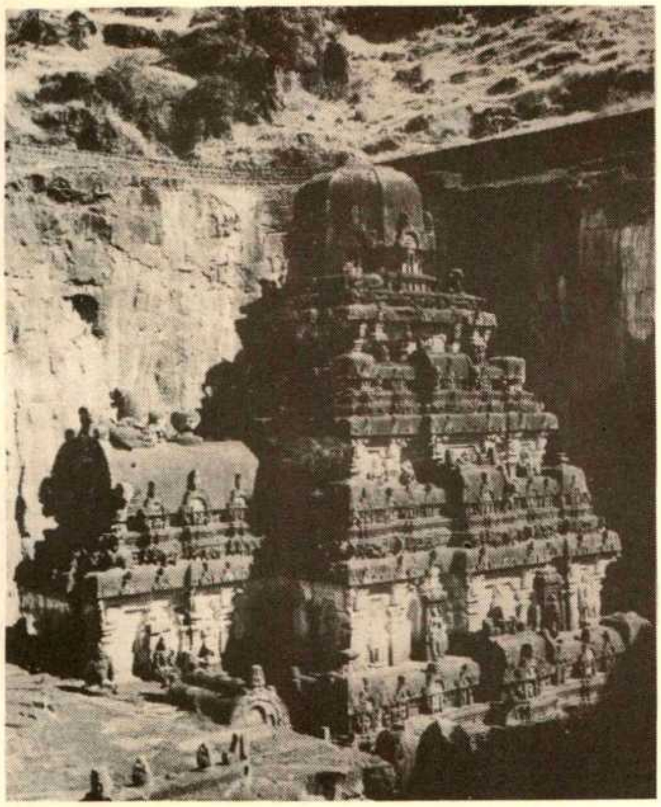

Fig. 2: Vimāna of the Kailāsa temple

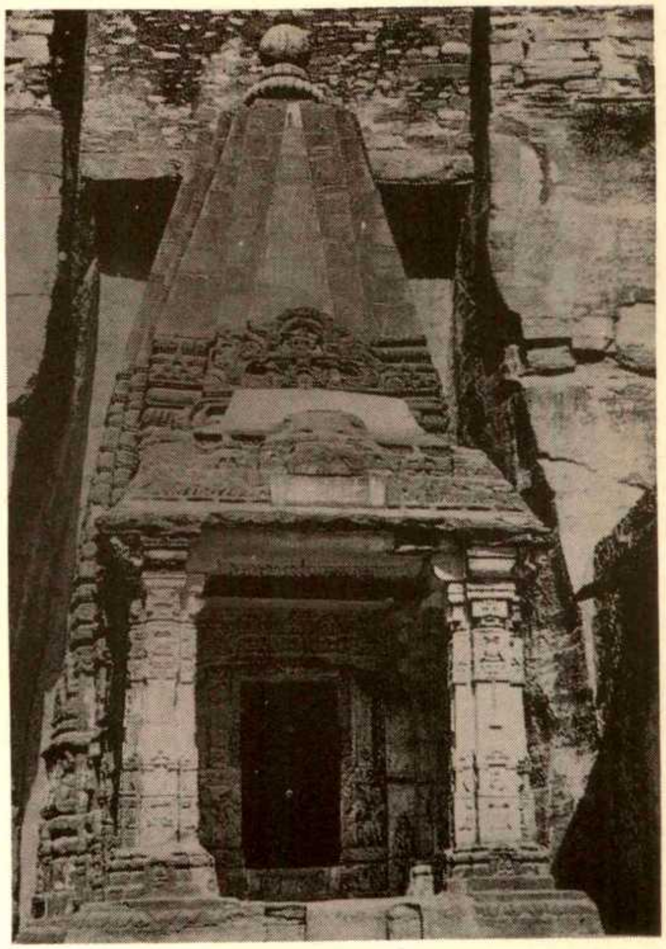

Fig. 4: Rock-cut, monolithic temple dedicated to Chaturbhuja Vishnu

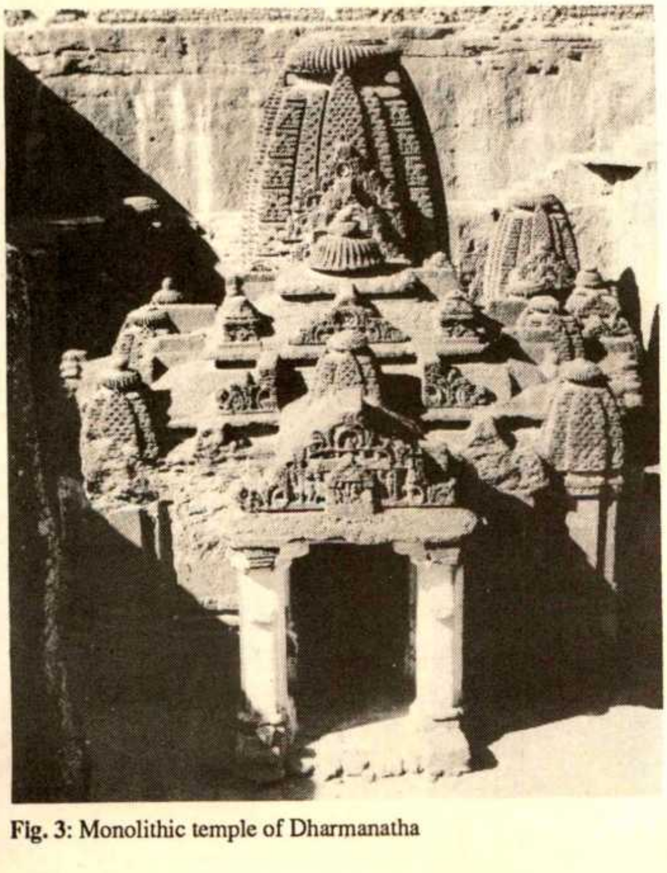

Fig. 3: Monolithic temple of Dharmanatha

Kailāsa monolith at Ellora is called Ghṛṣṇeṣvara as this appellation is also derived from the verb *ghṛś* to rub, grind or polish, evidently because it was carved smooth by chiselling. The inscription on the Chaturbhuja temple also describes in glowing terms the Trivikrama image carved on the northern *bhadra* niche. It mentions that Visnu's foot, raised to measure the sky, terrified the horses of the Sun God. The second inscription refers to the construction of the Navadurga temple and also to some donations. The inscriptions are dated to A.D. 875 and 876.

The third example is of the Pandyan monolithic temple of Vettuvanankovil — a rock-cut temple at Kalugumalai, in Tirunelveli District, Tamil Nadu (Fig. 6 and 7). It belongs to the eighth-ninth century and is similar to the Kailāsa temple at Ellora. The Vettuvanankovil temple is cut out of the hill-side like the Pallava creations at Mahabalipuram. The maximum depth to which the trenches were cut is 10.5 m, the length and width measuring 25 m and 13 m, respectively. The double storeyed *vimāna* (8.5 m square at the base) and the *ardha-maṇḍapa* (4 m wide across its facade) are incomplete. However, the finished upper parts reveal a high degree of skilled workmanship and contain some excellent sculptures such as that of *Dakśinamūrti* playing on the *mṛdanga*.

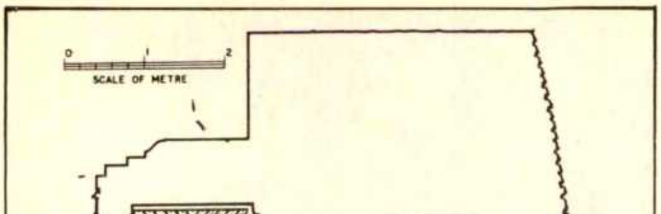

Fig. 5: Plan of rock-cut monolith of Chaturbhuja temple

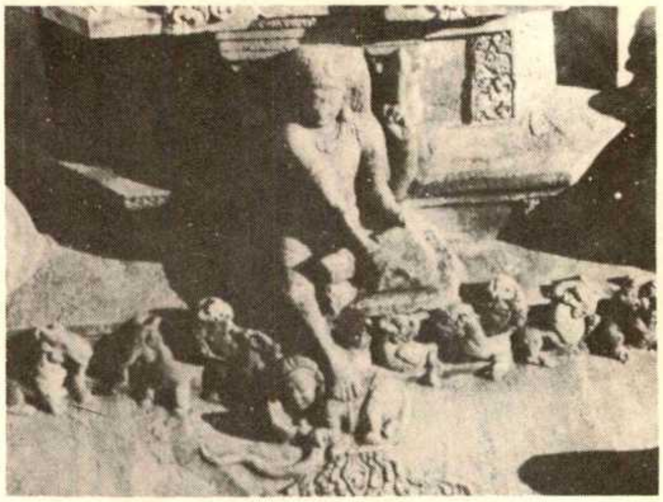

Fig. 7: Vimāna of the Vettuvankoil monolith with mṛdanga Dakśhinamūrti

This deity is also depicted in the Kailāsa temple of Ellora where he is shown seated in *padmāsana*. The other sculptures include those of Narasiṃha, Brahmā, Viṣnu, Skanda, Candra, Surya and the playful Śivagaṇas. It is significant to note that, on the hillock, near the rock-cut temple, are carvings depicting Jain *tīrthankaras*, among which the figures of Pārśvanātha, Yakṣinis, Padmāvati and Ambikā are noteworthy. The location of this Pandyan monolith, in close proximity to the Jain sculptures, makes one wonder whether it was intended to signify the conversion of the Pandyan ruler, either Maravarman Avanisulamani (A.D. 640-644) or his grandson, Arikesari Maravarman (A.D. 670-700), from the Jain to the Brahmanic faith. The *Perīyapurānam* account of the saints and the hymns of Appar reveal that in both the Pallava and Pandya countries, the Jains were looked down upon and subjected to persecution by the kings who had been converted to Brahmanism.

The fourth great monument of the same period, which is Vaiṣnava in character, is at Masrur, near Kangra, in Himachal Pradesh (Fig. 8 and 9). This temple can also be assigned to the nineth century and, it is surmised by some, that only a royal patron, such as Yasovarman of Kannauj, could have undertaken such an ambitious enterprise. Un-

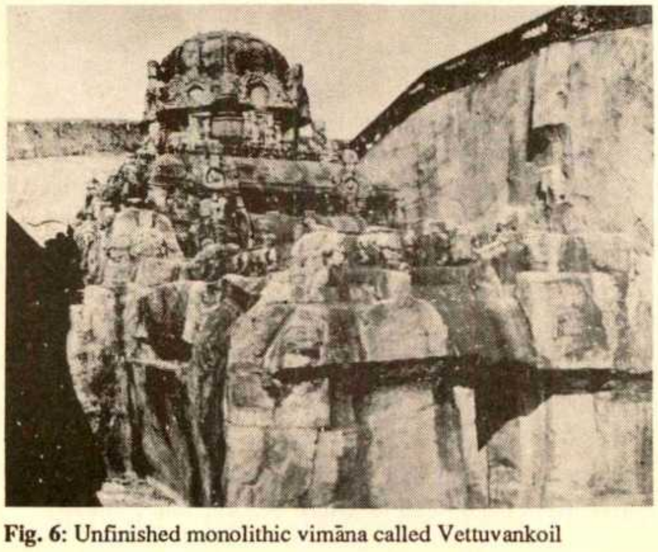

Fig. 6: Unfinished monolithic vimāna called Vettuvankoil

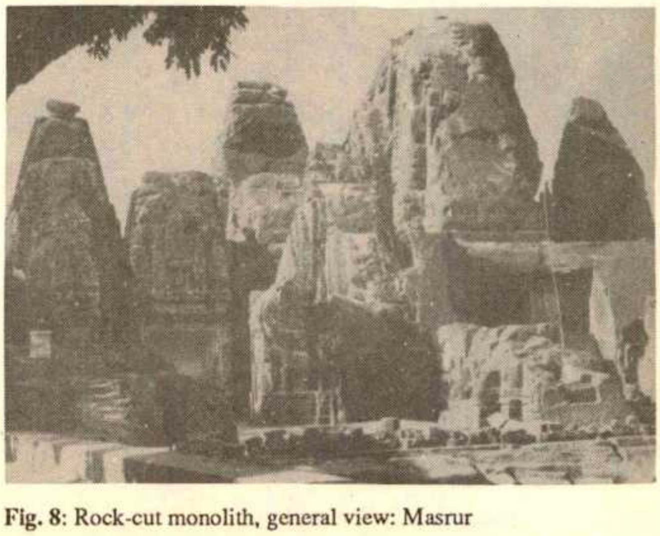

Fig. 8: Rock-cut monolith, general view: Masrur

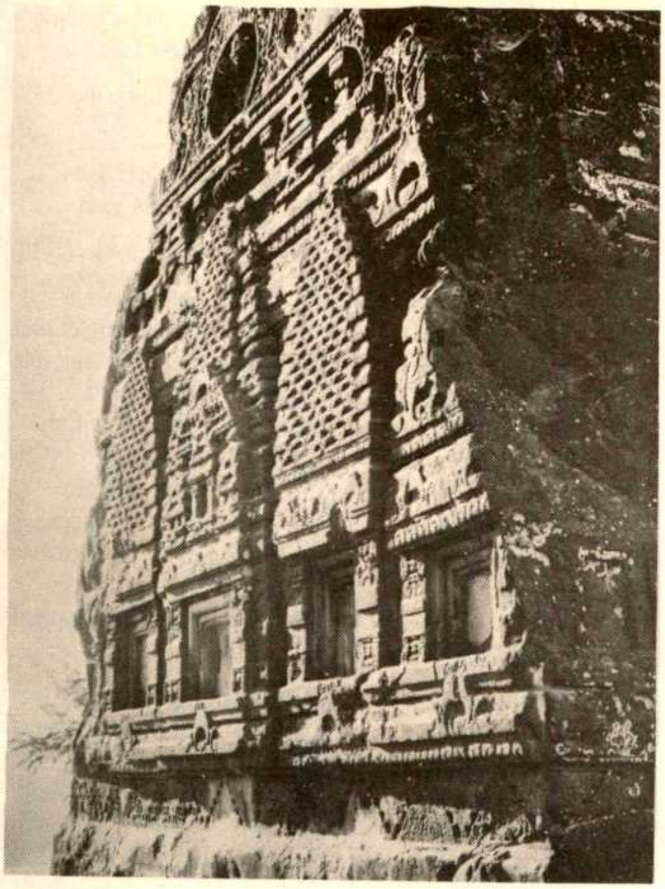

Fig. 9: Carved niches on the wall of the monolith: Masrur

doubtedly it carries forward the tradition of peninsular India, as typified by the Kailāsa monolith. In this regard, it is well-known that by the time the Rashtrakutas came to power, in the eighth and ninth centuries, communication between the north and south was well established, and artistic and architectural traditions as well as common idioms made themselves felt in both the regions of the Subcontinent.

Very recently yet another monolithic temple has been located by Shri G.T. Shende of the Archaeological Survey of India. It is situated at a place called Wasvi, on the bank of the Karam river in Dhar District, Madhya Pradesh (Fig. 10). It is half-buried, but the exposed portions clearly indicated that it has been built in the Dravidian style, similar to that of the Kailāsa temple.

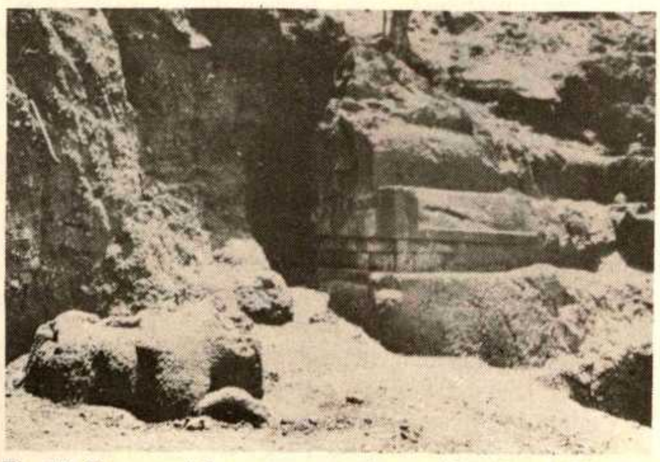

Fig. 10: Close-up of the rock-cut temple, partially cleared: Wasvi

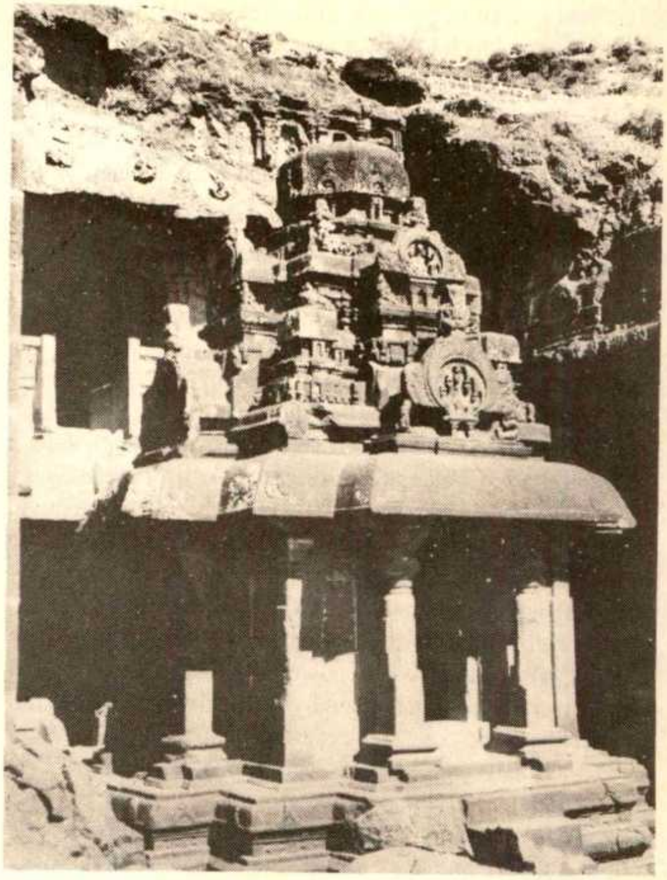

Fig. 11: Rock-cut Sarvatobhadra monolith in the courtyard of the Jain Cave, Indra-sabha

All these parallelisms are striking enough, but scholars might point out that such monoliths were originally carved at Mahabalipuram in Tamil Nadu. These monoliths, called *rathas*, were of the nature of architectural models copying contemporary monuments built in stone and brick and were not meant for worship. This early rock-cutting tradition was begun by Mahendravarman (A.D. 610-640), who was a versatile innovator in artistic and architectural activities, and was called *vicitrachitta*, the curious minded. Thus, we find that within the span of two centuries, i.e., in the latter part of the eighth and the early part of the ninth, six great monolithic temples, three in the Dravadian style and an equal number in the *nāgara* style, came to be carved in different parts of India.

This innovative monolithic tradition also inspired the Jain patrons who carved a monolith in the courtyard of the Jain Cave — Indra-sabha, almost a century later (Fig. 11). It would be appropriate to glance at the historical and socio-cultural situation that prevailed during this period, for it is often said that monumental creations represent the spirit of the cultural and technological progress of the age. During this period, Śaṇkara preached *Advaita Vedanta* with such vigour that under its onslaught Buddhism, which advocated nihilism (*Śunyavāda*) and atheism (*Nirīśvaravāda*), started losing its influence and nearly vanished from the land of its birth.

On the political map of India, we find that the Arabs had occupied Sind at the beginning of the eighth century. In the Deccan, Dantidurga had claimed his independence and by slow stages had overthrown the Chalukyas and established a new dynasty called the Rashtrakutas. The Pallavas were already on the decline, but their successors, the Cholas, had not yet entered the fray. The Pandyas, along with their feudatories, the Cholas, were preparing to oust the Pallavas which they succeeding in doing in the early part of the ninth century. In North India, Gopala, who was elected as a leader by the local chieftains, established the Pala dynasty around A.D. 750, and his son and successor soon made it a force to reckon with in north Indian politics. Simultaneously, under Bhoja, the Pratiharas rose to power and Bhoja captured Kannauj which had been taken by the Rashtrakutas from the Palas. Thus, three powerful dynasties, namely, the Rashtrakutas, Pratiharas and the Palas were ruling the Indian subcontinent during the period under consideration. By this time, communications between the north and south were well-established and large armies and caravans could move from one part of the country to the other, for the purpose of conquest or for the transport of essential commodities. This mobility also facilitated the movement of artists and craftsmen who were in demand by royal patrons for the purpose of raising temples and other religious monuments. The monarchs built temples to commemorate their victories, and in doing so, they employed styles prevalent in the regions conquered by them. Thus, they caused the craftsmen and *sthapatis* to migrate to new lands and build edifices in the styles in which they were adept. This was conducive to the transfer and intermixture of styles and the worship of new deities. It is not unlikely that new modes of worship were also introduced by the transfer of priestly families from one region to another. Is it not well-known that Vikramaditya II (A.D. 733-744), the Chalukyan monarch who defeated Nandivarman Pallavamalla (A.D. 731-766), was so struck by the artistic grandeur of the Kailāsanātha temple at Kanchipuram that he brought back with him the *sthapatis* who had built the temple. The Virupaksha temple at Pattadakal stands as a lasting memorial of his undying zeal. Further, the Kailāsanātha monolith at Ellora is in the Dravidian style of architecture and bears the impact of Pallava and Chalukyan architectural styles.

At this point, let it be said that although all the above-mentioned monoliths were meant for the *saguṇa* form of worship, they were very special creations combining the ideals of devotion and absolutism, as typified by Śaṇkarāchārya. It may be stated that Śaṇkara did not neglect *bhakti* but absorbed it in his scheme of the Absolute.

Drāvidadesha is traditionally considered to be the region where *bhakti* originated.

> *Utpannā dravide sāhaṁ vṛidhiṁ Karṇāṭake gatā,*
> *Kiñcitkvacinmahārāṣṭre Gurjare jīrṇatāṁ gatā.*
>
> *Shrimadbhāgavatamahāpurāṇa* (1-48).

It is also said that *bhakti* was later spread through North India by Ramanand. From the fifth to the ninth centuries many Śaiva saints like Sambandar, Appar and Sundarar flourished in South India, and their devotional hymns constitute one of the most valuable literary treasures of the world. The torch of *bhakti* ignited by these saints in Drāvidadesha shed its light far and wide. In the eighth century, we find it illuminating the heartland of the Deccan; and the great temple of Kailāsa at Ellora built by the Rashtrakuta monarch Krishna I (A.D. 756-775), not only symbolises *bhakti*, but it is also the northernmost example of Dravidian architecture of that time.

Thus, the religious sentiment that influenced the great temple of Kailāsa is undoubtedly that of *bhakti*. Equally important is its monolithic character which stands for *Advaita*. The Baroda copper plate grant (Fleet 1883) issued by the Rashtrakuta king, Karka, in A.D. 812-813, mentions that the celestials moving in their aerial chariot saw the Śiva temple in the Elāpura mountainside and were wonderstruck. They called it a *Svayambhu* temple, as if to convey that is is like Brahman, the Ultimate Reality.

> *Elāpurācalagatādbhuta sanniveśaṁ yadvīkṣya vismita vimānacarā marendrāḥ. Etatsvayaṁbhu śivadhāmana kṛtrime śrīdṛṣṭe dṛśīti satataṁ bahu carcayanti. Bhūyastathāvidhakṛtau vyavasāyahāneretanmayā kathamaho Kṛtamityakasmāt. Kaṙtāpi yasya khalu vismayamāpaśilpi. Tannām kīrtanamakāryata yena rājñā.*

With reference to the *bhakti* movement in Drāvidadesha, it may be pointed out that the first temple to Kailāsapati Śiva built in Tamil Nadu was the outcome of the intense devotion of the saint Appar (A.D. 610-619). Appar is said to have undertaken a very long journey on foot from his native Tamil country to the Himalayas, visiting holy places on the way, and singing the praises of Lord Śiva. He is credited with having visited no less than one hundred and twenty-five shrines of Lord Śiva, which are scattered over a large territory in Tamil Nadu and North Karnataka. His desire to visit Kailāsa, the grand abode of Śiva was so intense that, during his arduous journey to the snowy mountain, he nearly lost his legs due to extreme cold and frost, but managed to move forward by crawling on his hands and knees. Sekkizhaar, the hagiographer of the saints of Tamil Nadu, in his work *Periya-Puraṇam*, describes at length the journey of Appar to Varanasi and beyond to the

Himalayas. In this work, it is mentioned that during his journey, Appar met Lord Śiva who appeared in the guise of a *ṛisi* and commanded the saint to:

> 'Dive in this pond and see us in Thiruvaiyaaru of unblemished glory exactly in the same state as we are seated in Kailāsa.'

Appar heard this command and had the beatific vision of Śiva and Parvati and returned to Thiruvaiyaaru (District Thanjavura). To commemorate this great miracle, a majestic temple, known as *Ten Kailāṣam* or *Dakṣina Kailāsa*, was built in this town. The temple was later rebuilt in stone by a Chola king. A second Kailāshnatha temple was built at Kanchipuram by Rajasimha (c. A.D. 700-728). Both the temples thus stand for the *bhakti* ideal of the Tamil Saiva saints who are known as *Aḷavars*.

The Kailāsa temple at Ellora is rock-cut and monolithic, in contrast with the two masonry temples mentioned above. The Kailāsa temple was scooped out from the rock of the mountain range at Elāpura. The chiselling of the outer mass, portion by portion, was tantamount to the progressive removal of ignorance (*avidyā*) and the emergence of the temple as the unfolding of the original nature of *Brahman*, which is knowledge incarnate. Every blow of the hammer on the chisel was like an act of *sadhana* symbolising *tapas* and *bhakti*, thereby resulting in the purification of the devotee. The Kailāsa temple is thus a creation symbolising *Advaita-bhakti*. This is explained by Kulkarni (1974) as follows: '*Advaita-bhakti* is regarded as a contradiction in terms. But confirmed monists like Madhusudan Sarasvati have shown that, *Advaita-bhakti*, far from being contradictory, is a truism. We start with *bhakti* and end in a unitive experience. In the very concept of *Advaita-bhakti* there is a reconciliation between absolutism (*Advaita*) and ethical and spiritual discipline (*bhakti*). Moral preparation and one-pointed contemplation or devout meditation are necessary, but the end is *Advaita-bhakti* which is the 'Unique power of soul which unites man with God... in which the union of man with God fulfils itself.'

Commenting on the passage in *Taittirīya Upanisad* (III, 10.5-6) Professor Ranade (1926: 257) mentions: 'When he (the mystic) had transcended the limitations of his earthly, etheric, mental, intellective and beatific sheaths, he sat in utter silence of solipsistic solitude, singing the song of universal unity, "How wonderful, how wonderful, how wonderful; I am the food, I am the food, I am the food; I am the food-eater, I am the food-eater, I am the food-eater; I am the maker of this unity, I am the maker of this unity, I am the maker of this unity", which utterances only mean, metaphysically, that he was himself all matter and all spirit as well as the connecting link between them both, and epistemologically, that he was himself the subject-world and the object-world as well as the entire subject-object relation — a stage of spiritual experience which has been well characterised by a modern idealist thinker as a stage where the difference between the field, the fighter and the strife vanishes altogether — the culmination of the unitive song being couched in terms which are only too reminiscent of like mystic utterances from other lands: "I am the first-born of the Law; I am older than the Gods, I am the navel of immortality; he that gives me, keeps me; him, who eats all food, I eat as food, I envelope the whole universe with splendour as of the Sun"'.

Śaṇkara, the votary of *Advaita*, was not antagonistic to *bhakti*. He was the author of innumerable *stotras* or devotional prayers and the enlightenment of Śaṇkara was not the result of a cold study of books but it was the outcome of an intense desire to realise the truth which, when turned towards a personal deity, becomes *bhakti*. In *Vivekacūdāmaṇi*, he asserts:

> *Mokṣakāraṇasāmagryāṁ bhaktireva garīyasī.*
> *Svasvarūpānusandhānaṁ bhaktirityābhidhīyate* (8).

'Among other things conducive to liberation, devotion (*bhakti*) alone holds the supreme place. The seeking after one's real nature is designated as devotion'.

Further, in the penultimate stanza of the *Gangāstaka*, Śaṇkara speaks of *Advaita-bhakti*:

> *Mātarjānhvi śaṁbhusaṅgavalite maulau nidhāyāñja-*
> *lim tvattīre vapuṣovasānasamaye nārāyaṇāṅgh-*
> *ridvayaṁ. Sānandaṁ smarato bhaviṣyati mama*
> *prāṇa prayāṇotsave. Bhūyādbhaktiravicyutā*
> *hariharādvaitātmikā śāśvatī* (9).

'Oh Mother, who always desires the company of Siva, when shall I be blessed with that unswerving and eternal unitive devotion imbued with which, I, when the hour of departure has drawn nigh, with hands raised on my head, sitting on thy sacred banks remember with great joy the feet of Narayana and yield up the ghost which will indeed be a great festival'.

Professor Rudolf Otto (1932: 153-154), while discussing Śaṇkara's attitude towards *bhakti*, says: 'Śaṇkara himself, in the lower level, is a throughgoing theist and that with ardor and holy zeal. His theology is here almost identical with that of later Ramanuja (outlined above) and his opposition to those who deny God and to their rival systems which oppose theism, is as great as that of his successor (Ramanuja). Therefore, he takes it for granted that the man who is redeemed of God does not turn back, but on the path of gradual redemption finds it at last in *Brahma-nirvana*. This explains as we have noted above the curious elasticity of the borderline entirely disappearing between higher and lower knowledge — a phenomenon which cannot be dismissed as merely "Indian synthetic thinking"'.

Śaṇkara's commentary on verse 55 of *adhyaya* XVIII of the *Bhagvadgita* refers to *Advaita-bhakti* as follows:

> *Sā parā jñānaniṣṭhā iti ucyate sā iyaṁ jñānaniṣṭhā ārtādi bhaktibhayāpekṣayā parā caturthī bhaktiriti uktā. Tayā parayā bhaktyā bhagavantaṁ tatvatḥ abhijānāti. Yadantarameva īśvarakṣetrajña-bhedabuddhīḥ aśetatā nivartate.*

This *Jñāna-nishtā* (devotion to knowledge) is referred to as the Supreme or fourth kind of devotion (*bhakti*) — supreme as compared with the remaining three kinds of devotion. By this supreme devotion the aspirant knows the Lord as He is, and immediately afterwards all consciousness of difference between the Iśvara and the *Kshetrajña* disappears altogether. Thus there is no contradiction in the statement that, "by that devotion of knowledge (the aspirant knows) me".

The *Śvetāśvastara Upanisad* also brings out the triune unity of *bhokta* (the enjoyer), *bhogya* (the enjoyed) and *preritāra* (the inspirer).

> *Bhoktā bhogyaṁ preritāraṁ... trividhaṁ brahmametat.*

The individual soul (*Jivātman*), the world (*jagat*) and God (*Īśvara*) are all *Brahma*, thus pointing to the all pervasive unity (see *adhyaya* 1, verse 12 of *Śvetāśvastara Upanisad*). Śaṇkara bases his monism on all such texts.

Brahman, according to Śaṇkara, is the only substratum of the apparent and illusory existence of the world (*Brahma satyaṁ jaganmithyā jīvo brahmaiva nāparah*). This is what is called the doctrine of *vivarta* (illusory manifestation) peculiar to Śaṇkara, as opposed to that of *pariṇāma* (modification) held by other *vedānta* schools and especially by the *Sankhya*.

Regarding the view of Śaṇkara on the two kinds of knowledge and *mokṣa*, Shri V.S. Ghate (1980: 188-189) has summed up the position and explained Śaṇkara's approach to idol worship and *Upāsanā* as follows: Corresponding to the two-fold distinction of *Brahman*, higher and lower, owing to *maya* or the two kinds of reality, absolute and relative, there are two kinds of knowledge and two kinds of *mokṣa* resulting therefrom. The higher knowledge consists in the distinction and thereby the freedom of the self from all its *upādhis*. It is the knowledge of the absolute unity of Brahman, apart from which nothing really is. The higher *mokṣa*, which arises simultaneously with such a knowledge, consists in the entire absorption of the individual soul into *Brahman*. This does not mean any approach of the individual soul towards Brahman or their union, such an idea being impossible where there is absolute identity; it is only a recovery, a restitution, a return, a becoming of the soul of what it has always been, a revival of its true nature.

On the other hand, the lower knowledge consists in the worship, or *upāsanā*, of the lower *Brahman*, or *Brahman* in its phenomenal state, conceived as a personal Lord and Creator, *Īśvara*. This *upāsanā* is obligatory on all who have not yet reached the highest knowledge. Such worshippers of a personal God are really worshipping *Brahman*, though in its phenomenal aspect, and they are promised as a reward, not only happiness on earth and in heaven, but, by way of preparation, a kind of second-class *mukti* (*karma-mukti*) which gradually leads to the complete deliverance or highest *mukti*.

In this sense it may be truly said that Śaṇkara did not attach or destroy idolatry, though with him it was always symbolism rather than idolatry. It may be easily understood how he condemned all ritualism and *karma* and at the same time defended the worship of popular gods. Idolatry, if understood in the right spirit, is nothing but religious symbolism; and, as such, it can be open to no objection. Symbolism there must be, whether in words or in things. Verbal symbols appeal to the ear and the symbols of things to the eye, and that is all the difference between them. Verbal symbolism is language; and, if this is allowed in religion why should not also the other? At one stage of its growth idolatry is a necessity. When the religious spirit is mature, symbols are either given up or suffered to remain from their harmlessness. Thus Śaṇkara allowed idols as symbols of the great Infinite for those who cannot raise themselves to the comprehension of the one, changeless, non-qualified *Brahman*.

The means of *mokṣa*: knowledge and knowledge alone can lead to *mokṣa*. For *mokṣa* is not something to be obtained or produced. It is only a realisation of our real nature, of which we can never be really deprived, but of which we have been only forgetful; it is therefore only knowledge that can be the means of *mokṣa*. The performance of actions, however, and the practice of moral virtues are allowed as being preparatory to knowledge. Good works, even merely ceremonial works, if performed from pure motives and without any hope of reward, form an excellent preparation for reaching that highest knowledge which it is the final aim of the *Vedānta* to impart.

We would also like to point out that the teachings of *Bhagvadgita* have influenced the symbolism of the Kailāsa. In the Gita (12.5) the *Saguṇa Upāsanā* is preferred to *Avyakta Upāsanā*, for the latter is very difficult (*kleśoadhikataresteṣāṁ avyaktā vyakta cetasāṁ*). The *saguṇa* manifestations of the Absolute Reality, as enumerated in the *Vibhuti Yoga* (chapter ten of the Gita), attracted the *bhaktas*, and in the Kailāsa temple, we find some of the *Vibhūtis* depicted in all their grandeur.

Among the *Vibhūtis* mentioned in the *Bhagvadgita*, the Himalaya is mentioned as the foremost among the immovable objects (*sthāvarāṇāṁ himālayaḥ*) and Kailāsa stands for Himalaya which is the most glorious peak of the mountain and the abode of Śiva. Prahlada, the great devotee of Viṣnu, and the foremost among the daityas (*pralhadascasmi daityanam*), who is mentioned as a great *vibhūti*, also finds a

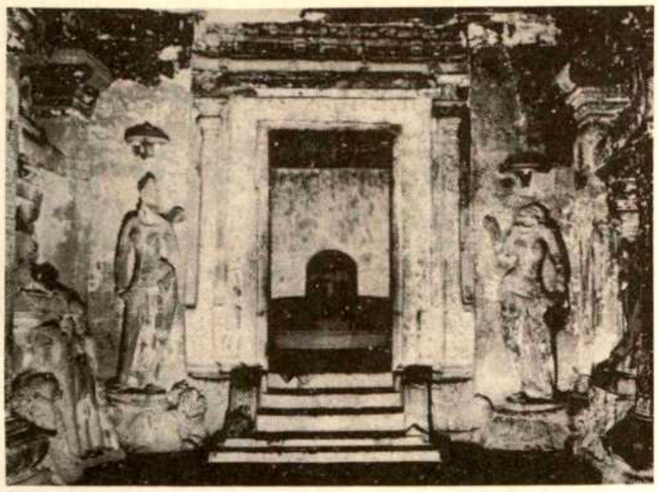

Fig. 12: Entrance to the garbha-griha of the Kailāsa monolith with Ganga and Yamuna flanking the entrance

prominent place, more than once, among the carvings in the great temple. Similarly, *Jānhavi*, *Kandarpa*, *Skanda*, *Śaṇkara*, *Viṣnu*, *Surya*, the elephant *Airāvata*, which are mentioned as *vibhūtis*, are also carved on the body of the temple in the courtyard; and the temple in its entirety is, as it were, *Brahman* incarnate.

It would be worth pointing out that *Śaṇkara* dealt a death blow to the spread of Buddhism, and both at Ellora and Dhamnar, the Brahmanical monolith was carved out at a time when Buddhist activity at both these places had nearly ended. There are thirteen Buddhist caves at Ellora and nearly fourteen at Dhamnar, and the monoliths carved at both these sites mark the victory of Brahmanism over Buddhism or of *Advaita-bhakti* over *Śunyavāda* and *Nirīśvarvāda*. In the case of Kalugumlai, the monolithic Śaivite *Vimāna* called Vettuvankovil stands close to the Jain sculptures carved on the hill, on the slope of which the monolith is carved. In the Dravida country, as pointed out earlier, Jainism was supplanted by Śaivism or Vaiṣnavism.

The Hindu temple and the various iconic representations sculpted on the body of the temple have a deep symbolic meaning. Monumental creations like the Kailāsanatha temple of Ellora have a very mysterious and divine import, their solemn majesty and glory overpowering the onlooker so as to cast a hypnotic spell over him. The late Dr. Guiseppe Tucci, learned art-historian and orientalist, in his forward to C. Sivaramamurti's (1976) book, *Sataruduya*, wrote: 'When we are confronted with a Hindu image, we are not only admiring its aesthetic values, but we are deciphering a symbol in which are concentrated centuries old intuitions: an image is a book in which primitive glimpses of universal archetypes are exalted into bold metaphysical systems and devotional mystic ecstacies; Indian art does not express things but sublimes ideas, complex meditations, flashing intuitions'.

Elsewhere (Deshpande 1988), the author has dealt with, in some detail, the symbolism of the various icons and therefore, here an attempt has been made primarily to understand the symbolism of the monolithic temples of which the Kailāsa temple at Ellora is the most outstanding example. However, it is worth noting that in the Kailāsa temple complex, a separate shrine is dedicated to Ganga, Yamuna and Saraswati; Ganga typifying purity, Yamuna standing for devotion, and Saraswati representing knowledge. Saraswati is proverbially absent in other temples where only Ganga and Yamuna are depicted on the door jambs of the entrance. In the sacred precints of Kailāsa, Ganga and Yamuna are carved at the outer entrance of the temple and again at the entrance to the sanctum sanctorum (Fig. 12). But the presence of Saraswati together with the other two river goddesses in a special shrine enhances the symbolic significance of these sculptures. If one was to have the vision of Śiva, the Ultimate Reality, it is through the unity of the Ganga, Yamuna and Saraswati, that is, through moral purity, devotional fervour and true knowledge. One cannot miss the fact that Kāmadeva and his spouse, Rati, also find a place in the architectural scheme of Kailāsa. They are so placed on the *pradakshiṇa-mārga* that when proceeding to the main temple, one has to turn one's back to them, thereby signifying that lust has to be bypassed or transcended if one wishes to reach the Divinity.

Professor Otto (1979)[5] uses the word 'numinous' as standing for that aspect of the deity which transcends or eludes comprehension in rational or ethical terms. He regards 'holy' as an *a priori* category beyond the categories of the good, the true and the beautiful. This term 'numinous' is considered a very important contribution to theological vocabulary and the learned author goes on to explain its import in depth. He uses the Latin words '*mysterium tremendum*' to describe the feeling of mystery and wonder as also the feeling one gets when the mind is filled with sympathy and imaginative intuition in an atmosphere that clings to old religious monuments and buildings, to temples and churches. The sentiment, according to him, 'is mixed with another sentiment which comes like a gentle tide, pervading the mind with a tranquil mood of deepest worship' (Otto 1979). In this there is also the feeling of overpowering energy (*majestas*), and something uniquely attractive and fascinating. He then compares this feeling to that felt by Arjuna when he saw the cosmic form (*viśvarūpa*) of Lord Krishna, a vision which was permeated with appalling frightfulness and most exalted holiness with an element of the 'grand'. One gets such a feeling of grandeur, sublimity, holiness, mixed with joy and mystery when one sees a monument like the Kailāsa temple.

In the appendix to the same work, Otto (1979) elucidates the concept of the 'numinous' in relation to Brahman, the wondrous and profoundly religious experience of *āścharya* one entertains while contemplating the Ultimate Reality (*Brahman*). He quotes verse 29 in chapter 2 of the *Bhagvadgita*:

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[5] Professor B.R. Kulkarni, in his communications to the author, had referred to the works of Rudolf Otto (1932, 1979). The author is very grateful to Prof. Kulkarni for this and for his advice on related matters.

> *Āścaryavatpaśyati kaścidenamāścaryavadvadati*
> *tathaiva cānyah. Āścaryavaccaivamanyaḥ sṛṇoti*
> *sṛtvāpyenam veda na caiva kaścit.*

This very feeling of *āścharya* or *viśmaya* overpowered the *sthāpati* who saw his own creation, the Kailāsa, from the aerial chariot, as described in the inscription on the Baroda copper-plate of the Rashtrakuta king, Karka II.

Saint Jnanesvara describes a similar sentiment in one of his *abhañgas* (an *abhañga* is a typical metrical form employed by Marathi saints) which can be placed in the category of *abhañgas* called *Kūta abhañga* (mysteries). The first four lines of the *abhañga* are as follows:

> *Ciñcecya panāvara śivalaya ubhavile ādhi kaḷasa*
> *maga pāyā re deuḷāmājī jātā deuḷa udāle praciddha*
> *sadguru rāyā re.*

'The temple dedicated to Siva was created on the tiny leaf of a tamarind tree with its pinnacle (*kaḷasa*) carved out first and its foundation later. When I entered such a temple for offering worship, the temple vanished in thin air, "Oh, my realised teacher!"'.

In this *abhañga*, the saint tries to describe his spiritual experience, the significance of which cannot be conveyed through words alone. He was so lost in devotion that when he entered the temple, it appeared to have vanished and he was filled with the blinding cosmic vision of the Ultimate Reality. This *abhañga*, together with the one from *Amritānubhava*, quoted earlier, epitomizes the concept of *advaita* where the devotee (*bhakta*), the God and the temple merge in 'Oneness'.

Acknowledgements

All photographs reproduced in this atticle are by the kind courtesy of the Archaeological Survey of India.

The editors thank Dr. Meera Arole for transliteration of the passages in Devanagari.

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Palaeoenvironment of the Late Palaeolithic of Primorye (The Former Far East U.S.S.R.)

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Abstract

Both Late and Final Palaeolithic sites were studied. A total of 8 reference settlements in Primorye were investigated. The Late Palaeolithic sites of the Cave of the Geographical Society and Osinovka belong to the warm Chernoruchie (Q^3_{III}) period, 25,000-35,000 B.P. The climatic conditions were comparatively warm and humid and the vegetation represented by coniferous-deciduous forests. The Late Palaeolithic sites of Ustinovka I, Suvorovo III, Suvorovo IV belong to the Sartan (Q^4_{III}) cold period, about 10,000-25,000 B.P. The climatic conditions were extremely cold and arid throughout the Late Pleistocene and the vegetation represented by birch forest-tundra and birch-larch thinned out forests. Around 15,000 B.P. a warming is noted (Suvorovo IV site); landscapes were represented by birch-hazel forests. The aceramic sites of Gorbatka III, Ilistaya I and Timofeevka I belong to the Late Glacial period (12,000-10,000 B.P.) and the Early Holocene (10,000-8,000 B.P.). The majority of these aceramic (or Final Palaeolithic) sites belong to the warm Boreal period, about 9,000-8,000 B.P. in the landscapes of birch-broad- leaved forests.

Introduction

A study of the geology and palaeogeography of the Palaeolithic sites in Primorye began in the 1950s (Petrun 1956; Ganeshin and Okladnikov 1956). Between the 1960s and 1980s, a number of sites were studied and palaeogeographical and chronological data were obtained (Vereschagin and Ovodov 1968; Nikolskaya 1970; Alekseev and Golubeva 1973; Andreeva and Khudyakov 1973; Ovodov 1977). At present, the main objective of geoarchaeological studies in Primorye is to obtain geochronological and palaeogeographical information about the basic Palaeolithic cultures which are the Ustinovka and Osinovka cultures (Derevyanko 1983) and the aceramic sites in the valleys of the Ilistaya and Razdolnaya rivers (Kuznetsov 1986).

From 1987 to the 1990s, in the course of a study carried out by a group of scientists including the author, new data on the palaeoenvironment of the Palaeolithic in Primorye were obtained (Kuzmin 1990a and b; 1991; Kuzmin and Chernuk 1990; Kuzmin *et al.* 1989).

Methods

To study the environment of the Palaeolithic sites in Primorye, 8 well-known settlements were chosen using archaeological criteria (Fig. 1). The Late Palaeolithic sites of Osinovka and the Cave of the Geographical Society relating to the Osinovka culture had been studied earlier (Ganeshin and Okladnikov 1956; Ovodov 1977). The sites in the Zerkalnaya river valley — Ustinovka I, Suvorovo III, Suvorovo IV — relating to the Ustinovka culture were also studied (Vasiljevsky and Gladyshev 1989). For aceramic sites in the Ilistaya and Razdolnaya rivers, the settlement of Timofeevka I with its homogenous cultural complex (without the presence of any later material) as well as the sites of Gorbatka III and Ilistaya I (Kuznetsov 1986), where a small amount of Neolithic and later material was found, were studied.

The main focus for research are the cultural layers of ancient sites. For palaeogeographical interpretation of the data obtained, the information from the reference sections of the Late Pleistocene-Holocene in southern Primorye have been taken into account (Korotky *et al.* 1980; Kuzmina *et al.* 1987).

The Palaeolithic sites in Primorye were palaeogeographically investigated using geomorphological, lithological, palynological and radiocarbon dating methods.

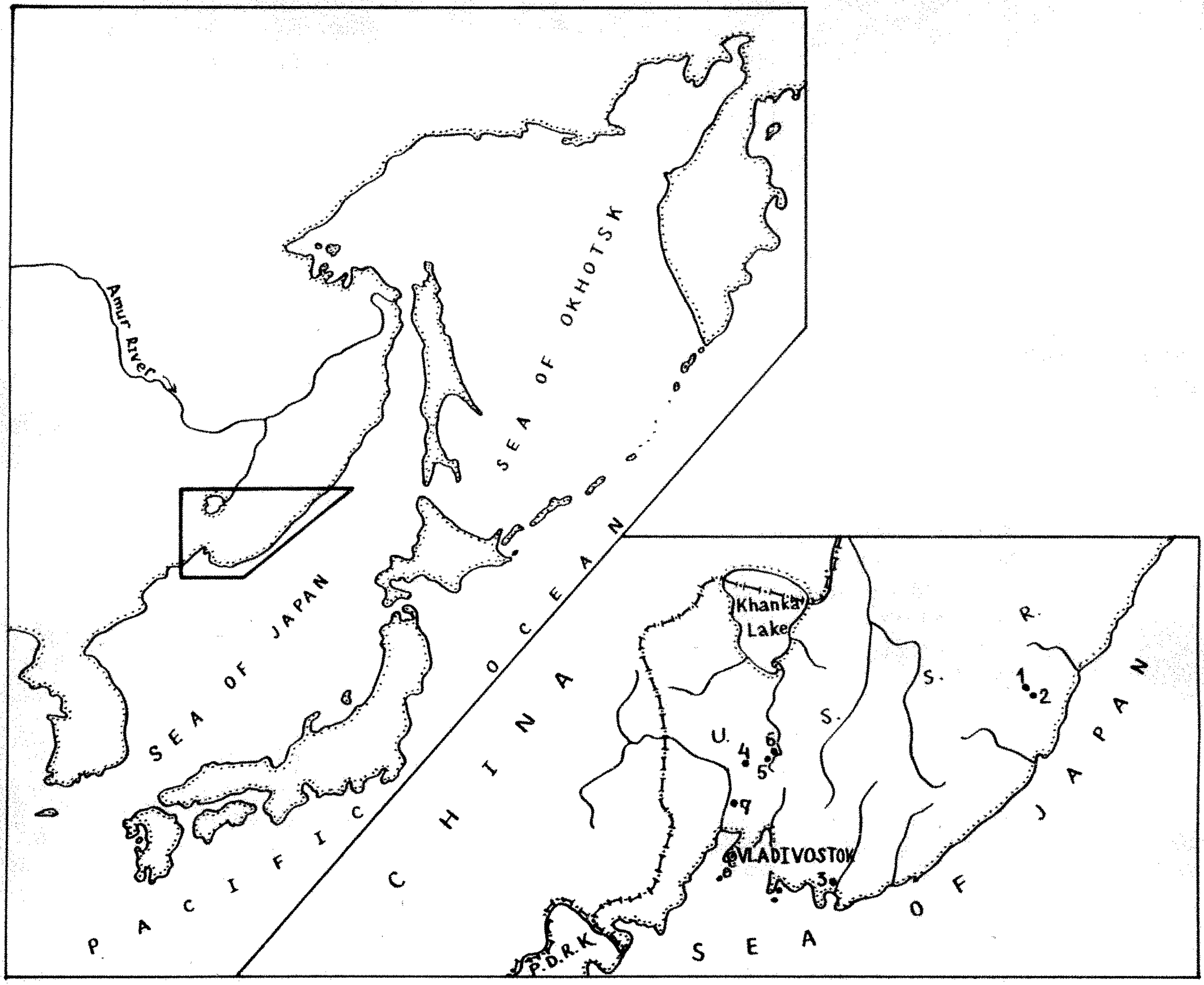


Fig. 1: Archaeological sites studied
1-Ustinovka I; 2-Suvorovo III - IV; 3-Cave of the Geographical Society; 4-Osinovka; 5-Gorbatka III; 6-Ilistaya I; 7-Timofeevka I

Results

At the Osinovka site a pollen spectrum from the Palaeolithic layer shows that ancient men lived in the landscapes of broad- leaved forests in mild climatic conditions (Nikolskaya 1970). However, the small sample of pollen from the section does not permit a reliable comparison between the Osinovka pollen data and the pollen spectra of any period of warming in the Late Pleistocene in Primorye. It is likely, that Osinovka belongs to the Chernoruchie (Q^3_{III}) warm period.

As for the Geographical Society Cave, which was excavated entirely, numerous mammal bones were obtained, as well as a small number of prehistoric implements (Okladnikov et al. 1968; Ovodov 1977). Vereschagin and Ovodov (1968) have determined, on the basis of the faunal data (Table 1), the age of the deposits containing artefacts as that of the Sartan (Q^4_{III}) cold period. The pollen data obtained for the lower cultural layer (Fig. 2: layer 5) show quite warm conditions during its formation. The pollen of *Pinus koraiensis*, *Picea omorica*, *Picea sect*, *Eupicea*, *Larix*, *Tilia*, *Quercus*, *Juglans*, *Acer*, *Ulmus*, *Betula manshurica* are observed and indicate the spread of coniferous-deciduous forests (Alekseev and Golubeva 1973). The age of the deposits, based on pollen data, is determined as the Chernoruchie warm period. The horse and mammoth bones found at a depth of 0.6-0.8 m have been radiocarbon dated to 32,570±1,510 B.P. (IGAN-341) which is consistent with Alekseev and Golubeva's (1973) conclusion.

Ustinovka I is a well-known and well-studied Late Palaeolithic site in Primorye (Okladnikov 1966; Andreeva and Khudyakov 1973; Vasiljevsky and Gladyshev 1989). Geomorphological and palaeogeographical studies were undertaken by Petrun (1956), Khudyakov (Andreeva and Khudyakov 1973) and Alekseev and Golubeva (1973).

Table 1: The mammalian fauna of the Geographical Society Cave (layers NN 4-5, Palaeolithic) (Ovodov 1977).

Species	**Number of bones**	**number of individuals**	**N%**	**n%**
Chirotera gen. sp.	74	?	—	—
Lepus sp.	16	2	0.3	1.2
Ochotona sp.	12	8	0.2	5.0
Microtinae gen.sp.	15	5	0.3	3.1
Myopus sp.	1	1	0.02	0.6
Canis lupus L.	390	13	7.9	8.0
Vulpes vulpes L.	19	4	0.3	2.5
Nyctereutes procionoides Gray	4	2	0.08	1.2
Cuon alpinus Pall.	20	2	0.4	1.2
Ursus arctos L.	175	9	3.5	5.5
U. tibetanus G. Cuv. (?)	1	1	0.02	0.6
Hyaena sp.	169	10	3.4	6.2
Mustela sibiricus Pall.	2	1	0.04	0.6
Martes flavigula Bodd. (?)	3	1	0.06	0.6
Gulo gulo L.	12	2	0.2	1.2
Meles meles L.	9	3	0.1	1.9
Lutra lutra L.	1	1	0.02	0.6
Felis bengalensis Kerr.	1	1	0.02	0.6
Panthera tigris L. a. P. spelaea Goldf.	233	5	4.7	3.1
Panthera pardus L.	31	2	0.6	1.2
Mammuthus primigenius Blum.	45	3	0.9	1.9
Equus caballus L.	230	9	4.7	5.6
Coelodonta antiquitatis Blum.	33	1	0.6	0.6
Sus scrofa L.	33	5	0.6	3.1
Moschus moschiferus L.	20	2	0.4	1.2
Capreolus capreolus L.	706	13	14.7	8.0
Cervus nippon Temm.	1224	29	25.3	18.0
Cervus elaphus L.	1008	8	20.9	5.7
Alces alces L.	108	3	2.2	1.9
Rangifer tarandus L.	1	1	0.02	0.6
Nemorhaedus goral Hard.	134	4	2.7	2.4
Bison priscus Boj.	196	5	4.0	3.1
Poephagus baicalensis N. Ver.	2	1	0.04	0.6
Ovis sp.	1	1	0.02	0.6
	4972	161	100	100

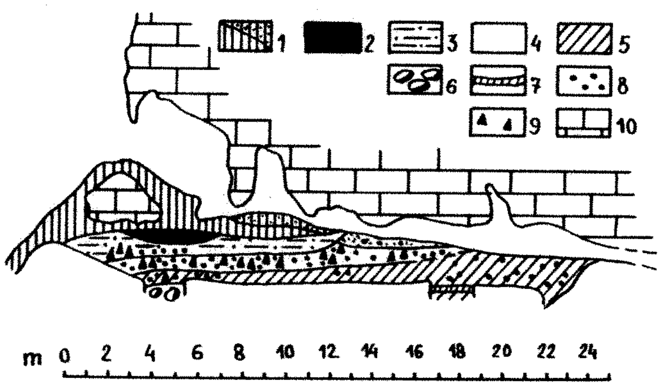


Fig. 2: Section of the Cave of the Geographical Society (Ovodov 1977)
1-layer 1; 2-layer 2; 3-layer 3; 4-layer 4; 5-layer 5; 6-layer 6; 7-silt layer; 8-Pleistocene mammal bones; 9-Palaeolithic artefacts; 10-limestone. Layers N 1-3 - Early Iron Age - Neolithic; layers NN 4-5 - Palaeolithic

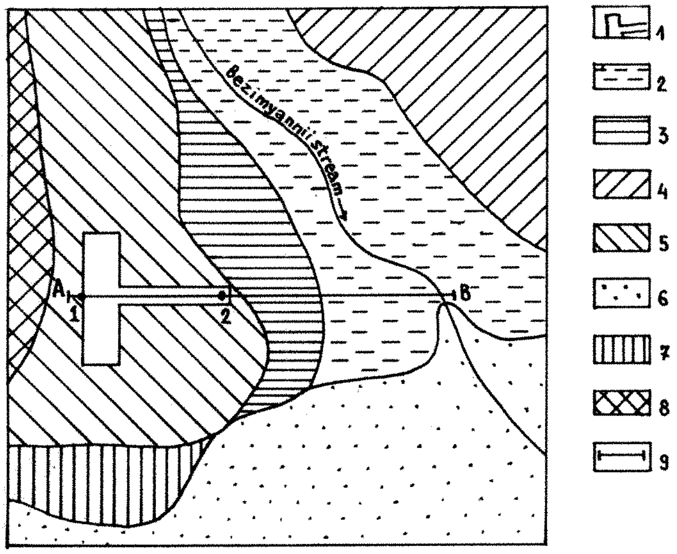
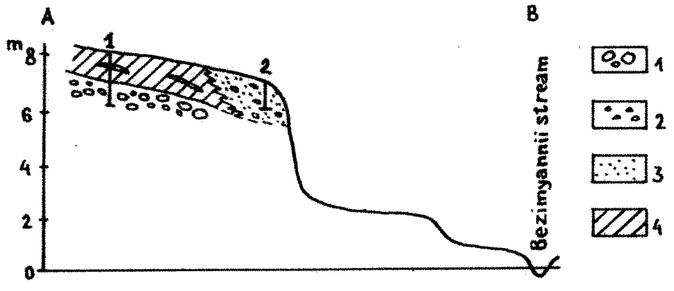


Fig. 3: Geomorphological scheme of Ustinovka I site
1-excavation site; 2-Bezyimyannii stream flood-plain; 3-1st terrace of the stream; 4-2nd terrace of the stream; 5-3rd terrace of the stream; 6-Zerkalnaya River flood-plain; 7-2nd terrace of the river; 8-hill slopes; 9-profile line



Profile across Ustinovka I site (line A-B)
1-boulders; 2-gravel; 3-sand; 4-loam with artefacts

The Ustinovka I site lies at the rear side of the 3rd terrace of the Bezymyannii creek (Fig. 3). The terrace surface is connected to the 2nd terrace of the Zerkalnaya river. A loose aggregate containing the cultural material is characterized by layers of loam of different colours and composition and inclusions of sand lenses.

The characteristic feature of Section N 1 (Fig. 3), found earlier (Alekseev and Golubeva 1973) is the presence of cryogenic textures — ground lodes and traces of solifluction deposits.

To study the genesis of the Ustinovka I section deposits, mineralogical analysis of the heavy fraction was carried out (Table 2). In Section N 1, ilmenite predominates (32-76%), while in Section N 2, rock fragments predominate (74-79%). On the basis of these data, some conclusions can be drawn (Kuzmin *et al.* 1989). For Section N 1 it may be said that the loam layers are slope deposits. This is determined by the close relationship with drift sources represented by the crust of weathered rocks (silicificated tufa). This relationship is based on the abundance of ilmenite. The gravel-pebble deposits containing material e.g. hornblende, brought from far away, can be attributed to facies with a higher dynamic activity (proluvium-alluvium?). The deposits of Section N 2 belong, most likely, to the stream bed facies of alluvium.

The ratio of the thickness of deposits at Sections N 1 and N 2 can therefore be presented as follows: at the edge of the stream terrace the alluvium accumulation took place, while in the near part, where the Ustinovka I site is located, the slope deposits accumulated. Most probably, the deposits of Sections N 1 and N 2 were accumulated more or less contemporaneously.

The Ustinovka I site is characterized by extremely poor pollen remains. On the basis of data obtained (Kuzmin *et al.* 1989), during the formation of the lower portion of Section N 2 in the vicinity of the Ustinovka I site, the birch forest-tundra was developed. The prevailing climatic conditions were probably mainly cold and arid.

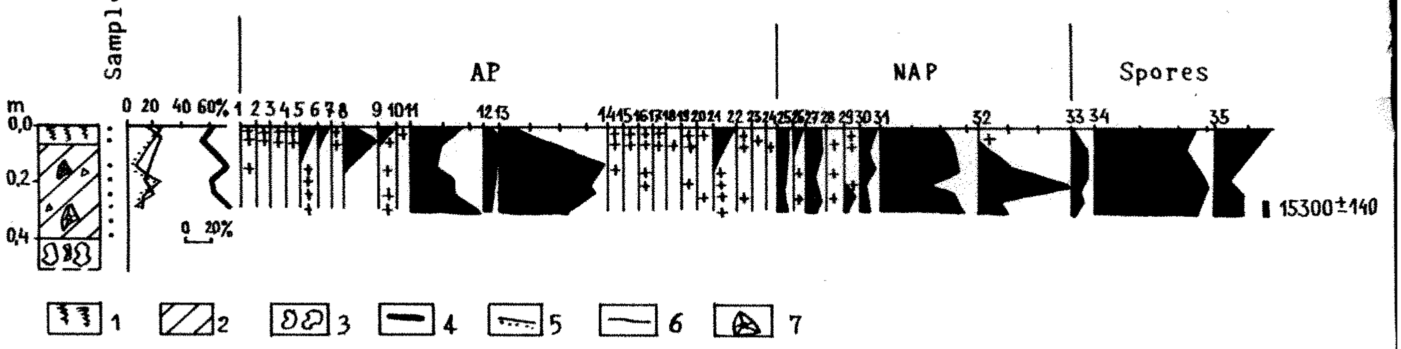
The Suvorovo III site is located on the 12-14 m terrace of the Kurchumka river, a tributary of the Zerkalnaya river. Archaeological data show that Suvorovo III is similar to the upper layer of Ustinovka I (Vasiljevsky 1985; Vasiljevsky and Gladyshev 1989).

Mineralogical analysis of site deposits (Table 2) show that in a heavy fraction the **authigenic** minerals (iron oxides and hydroxides) predominate (66-78%). Based on these data it might be said that the cultural layer lies in the upper part of the terrace sediments (sub-aerial loess-like loam). The sub-soil of the site of Suvorovo III is alluvial.

Based on pollen analysis (Kuzmin and Chernuk 1990), one can reconstruct the vegetation pattern during the period when the cultural layer was forming. The general appearance

Table 2: Mineralogical composition of sediments in Primorye (heavy fraction, 0,1-0,25 mm)

Depth m	Terrigenous minerals												Authigenous minerals
	Horn-blende	Other amphi-boles	Pyro-xenes	Epidote group	Bio-tite	Rock frag-ments	Limon-pseudo-morphoses on pyrite	Ilmen-ite	Rutile, leuco-xene	Garnet	Zircon	Tour-ma-line	Iron oxides and hydroxides
1	2	3	4	5	6	7	8	9	10	11	12	13	14
						Ustinovka I, section N 1							
0,15-0,25	—	—	—	1,0	—	16,0	—	72,0	1,0	—	—	—	10,0
0,25-0,35	—	—	—	—	—	36,0	—	64,0	—	—	—	—	—
0,35-0,50	2,0	—	—	—	—	9,0	—	38,0	—	—	1,0	—	48,0
0,50-0,70	—	—	—	2,0	—	11,0	—	73,0	2,0	—	—	—	12,0
0,70-0,75	—	—	2,0	—	—	5,0	—	32,0	2,0	—	—	—	59,0
0,75-0,95	4,0	—	—	—	—	20,0	—	76,0	—	—	—	—	—
0,95-1,15	8,0	—	—	—	—	16,0	—	74,0	—	—	—	2,0	—
						Ustinovka I, section N2							
0,25-0,55	—	—	—	—	—	79,0	—	11,0	2,5	1,5	1,0	3,0	—
0,75-0,90	6,0	—	5,0	—	—	74,0	—	12,0	—	1,0	2,0	—	—
						Suvorovo III							
0,0-0,07	—	—	—	3,0	3,0	9,0	—	7,0	—	—	—	—	78,0
0,07-0,37	0,5	—	2,0	—	—	17,0	1,0	13,0	—	0,5	—	—	66,0
						Timofeevka I							
0,0-0,12	4,0	3,0	—	4,0	4,0	51,0	—	31,0	—	1,0	1,0	1,0	—
0,12-0,35	3,0	—	—	7,0	7,0	46,0	—	34,0	0,5	1,0	—	0,5	1,0
0,35-0,65	2,0	2,0	—	6,0	7,0	53,0	—	28,0	1,0	0,5	—	0,5	—
0,90-1,30	14,0	3,0	14,0	22,0	18,0	26,0	—	16,0	—	0,5	—	—	0,5
1,30-1,70	7,0	4,0	16,0	10,0	9,0	45,0	—	9,0	—	—	—	—	—
Ilistaya I													
0,0-0,25	—	—	7,0	—	—	24,0	—	—	—	—	—	—	69,0
0,25-0,40	—	—	61,0	—	—	17,0	—	3,0	—	—	—	—	19,0
0,40-0,60	—	—	6,0	—	—	38,0	—	—	—	—	—	—	66,0



Analysis: N.B.Verkhovskaya 1990

Fig. 4: Pollen diagram of Suvorovo IV site
1-turf; 2-loam; 3-boulders; 4-arboreal pollen (AP); 5-non-arboreal pollenn (NAP); 6-Spores; 7-artefacts. Pollen & Spores: 1-Abies; 2-Larix; 3-*Picea* sect. *Eupicea*; 4-P. sect. *Omorica*; 5-*Pinus s/g Haploxylon*; 6-P. cf. *koraiensis*; 7-P. *s/g Diploxylon*; 8-*Salix*; 9-*Alnus*; 10-*Alnaster*; 11-*Betula* (trees); 12-*Betula* sp.; 13-*Corulus*; 14-*Carpinus*; 15-*Ulmus*; 16-*Tilia*; 17-*Phellodendron*; 18-*Syringa*; 19-*Juglans*; 20-*Acer*; 21-*Quercus*; 22-*Viburnum*; 23-*Lonicera*; 24-*Rosa*; 25-*Poaceae*; 26-*Cyperaceae*; 27-*Thalictrum*; 28-*Chenopodiaceae*; 29-*Rosaceae*; 30-*Umbelliferae*; 31-*Artemisia*; 32-*Asteraceae (Compositae)*; 33-*Bryales*; 34-*Polypodiaceae (monolethnic)*; 35-*Polypodiaceae (threelethnic)*

of the spectrum for the lower part of this layer is arid and cold. The vegetation was represented by birch forest-steppe with bush thickets (cedar, alder, shrub birchs). The pollen spectrum from the middle part indicates cool and slightly moister conditions than those in the previous part. In the vegetation cover, birch forests and thickets of shrub birch and hazel predominate. The spectrum of the upper part of the cultural layer indicates *sufficiently* warm conditions and the predominance of the deciduous and birch forests with a small amount of hazel.

The Suvorovo IV site is located on the gentle slope of low mountain relief, at a height of 18-20 m above the surface of the Sadovaya river, a tributary of the Zerkalnaya. Archaeological studies show that Suvorovo IV is similar to the upper layer of Ustinovka I and to Suvorovo III with respect to cultural inventory (Vasiljevsky and Gladyshev 1989; Gladyshev and Tabarev 1989).

For the cultural layer of Suvorovo IV, a pollen diagram was obtained (Fig. 4). On the whole, in this layer, arboreal pollen predominate (58.9-76%). The content of non-arboreal pollen and spores are 7.5-25.7% and 11.2-12.4% respectively. Among the arboreal pollen, *Corylus* and *Betula* (arborescent) predominate. Further up the section, the content of *Corylus* pollen increases (from 43.4% to 74.6%), while the content of *Betula* decreases (from 49.2% to 14.7%). Single pollen grains of *Pinus* (*Haploxylon*), *Alnus*, *Tilia* and *Quercus* are present. The non-arboreal pollen is mainly represented by *Artemisia* (22.0-60.9%), *Asteraceae* (8.9-62%), and the spores of *Polypodiaceae* predominate.

In ancient times the vegetation in the vicinity of the Suvorovo IV site, was represented by birch-hazel associations and during the formation of deposits overlapping the cultural layer, birch-hazel forests with a willow and oak admixture were present. The radiocarbon dating of charcoal (depth 0.25-0.3 m) shows an age of 15,300±140 B.P. (Ki-3502).

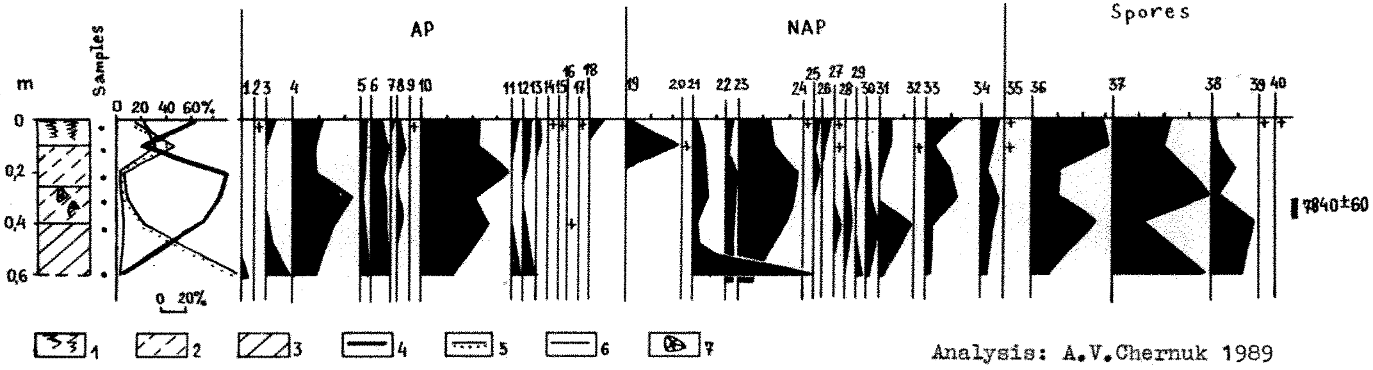


Fig. 5: Pollen diagram of Ilistaya I site
1-turf; 2-sandy loam; 3-loam; 4-AP; 5-NAP; 6-Spores; 7-artefacts. Pollen & Spores: 1-*Abies*; 2-*Picea*; 3-*Pinus koraiensis*; 4-*Betula (B. dahurica+B. schmidtii+B. manshurica)*; 5-*B.lanata+B. costata*; 6-*B.exilis*; 7-*Salix*; 8-*Alnus*; 9-*Carpinus*; 10-*Corylus*; 11-*Tilia*; 12-*Quercus*; 13-*Ulmus*; 14-*Syringa*; 15-*Celastraceae (Euonymus)*; 16-*Araliaceae*; 17-*Populus*; 18-*Juniperus*; 19-*Ephedra monosperma*; 20-*Vacciniaceae*; 21-*Poaceae*; 22-*Cyperaceae*; 23-*Artemisia*; 24-*Typha*; 25-*Alliaceae*; 26-*Apiaceae*; 27-*Fabaceae, Borraginaceae*; 28-*Caryophillaceae*; 29-*Geranium, Polemonium*; 30-*Polygonaceae, Rumex*; 31-*Ranunculaceae, Thalictrum*; 32-*Rosaceae*; 33-*Asteraceae*; 34-*Varia*; 35-*Equisetum, Sphagnum*; 36-*Bryales*; 37-*Polypodiaceae*; 38-*Pteridium*; 39-*Lycopodium serratum*; 40-*Selaginella*

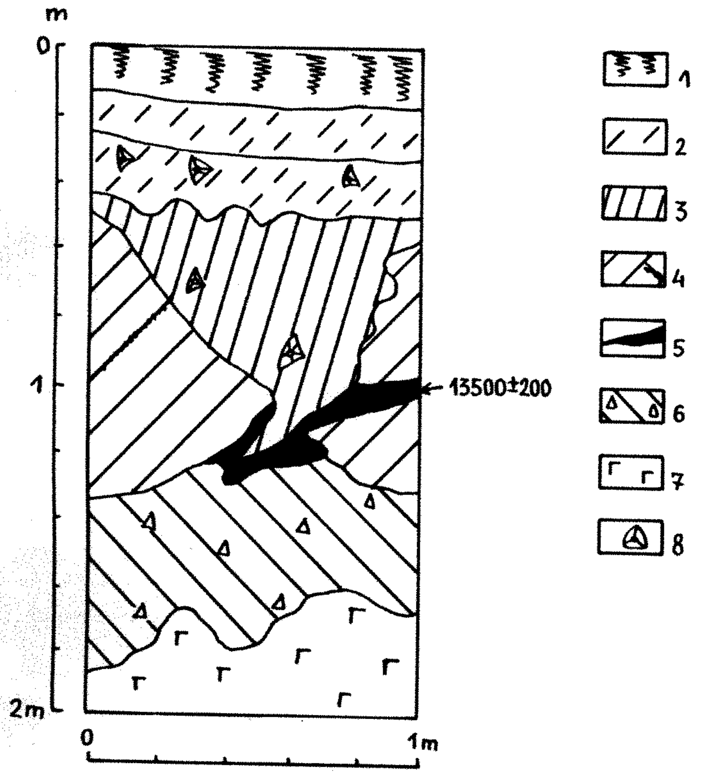


Fig. 6: Cross-section of Gorbatka III site (A.M. Kuznetsov 1985) 1-turf; 2-sandy loam (Palaeolithic cultural layer N 1); 3-material of ice wedge (loam); 4-reddish-brown loam; 5-lens of organic material (was dated by ^{14}C); 6-grussy loam; 7-weathered basalt; 8-artefacts

Geoarchaeological data obtained for the Palaeolithic of the Zerkalnaya river basin allow a reconstruction of the palaeogeographical conditions of ancient life. Based on data for the Ustinovka I site, its age is likely to be within quite wide limits: 10,000-25,000 B.P. Paucity of data does not allow this interval to be narrowed. The climatic conditions of prehistoric life at Ustinovka I were periglacial. The site of Suvorovo IV enjoyed fairly warm conditions around 15,000 B.P. in comparison with the maximum of the Sartan period (Q^4_{III}). Suvorovo III can be asigned to the Pleistocene/ Holocene boundary, about 10,000 B.P. The pollen data from Suvorovo III show clearly the change from arid and cold conditions to fairly wet and cool conditions.

A number of aceramic sites in Primorye, e.g. Timofeevka I, Gorbatka III, Ilistaya I, are assigned to the Final Palaeolithic stage. They are dated to 8,000-12,000 B.P. (Kuznetsov 1986; 1990). At the above sites, the first geoarchaeological studies were carried out by the author.

The Timofeevka I site is on the 15-17 m terrace of the Popovka river, a tributary of the Razdolnaya river. The cultural layer of this site comprises only the stone inventory without any admixture of later material.

Deposits underlying the cultural layer are related to the Ust-Suifun suite of Upper Miocene deposits shown in the geological map of Bazhanov and Oleinik (1988). Mineralogical analysis of the sub-soil (Table 2) shows that the heavy fraction has a comparatively rich set of minerals: the rock fragments constitute 46-53%, ilmenite (28-34%), biotite (4-7%), the group of epidote-zoesite (4-7%) and hornblende (2-4%) are found in the largest amounts, while the amphiboles (except hornblende), garnet, zircon, tourmaline, rutile, leucoxene are found in smaller amounts. The content of **authigenic** minerals does not exceed one percent.

Based on this mineralogical analysis, one can assume that the cultural layer lies on deposits formed under conditions of quite high dynamic activity, most likely, alluvial ones. The genesis of the Upper Miocene bedrock, which lies below, is evidently also alluvial.

For the Timofeevka I site, a pollen diagram was obtained, based on which it might be said that, in prehistoric times vegetation in the vicinity of Timofeevka I was represented by birch-hazel forests with an admixture of linden. Later, in the territory adjacent to the site, deciduous forests existed where hazel and linden dominated.

The Ilistaya I site is located in the Ilistaya river valley, on the high (15-20 m) terrace-like surface. The bedrock exposure is made up of the basalts of the Shufan suite of the Pliocene (Bazhanov and Oleinik 1988). Mineralogical analysis of the Ilistaya I site deposits (Table 2) indicates the **eluvial-deluvial** genesis of the deposits of the cultural layer.

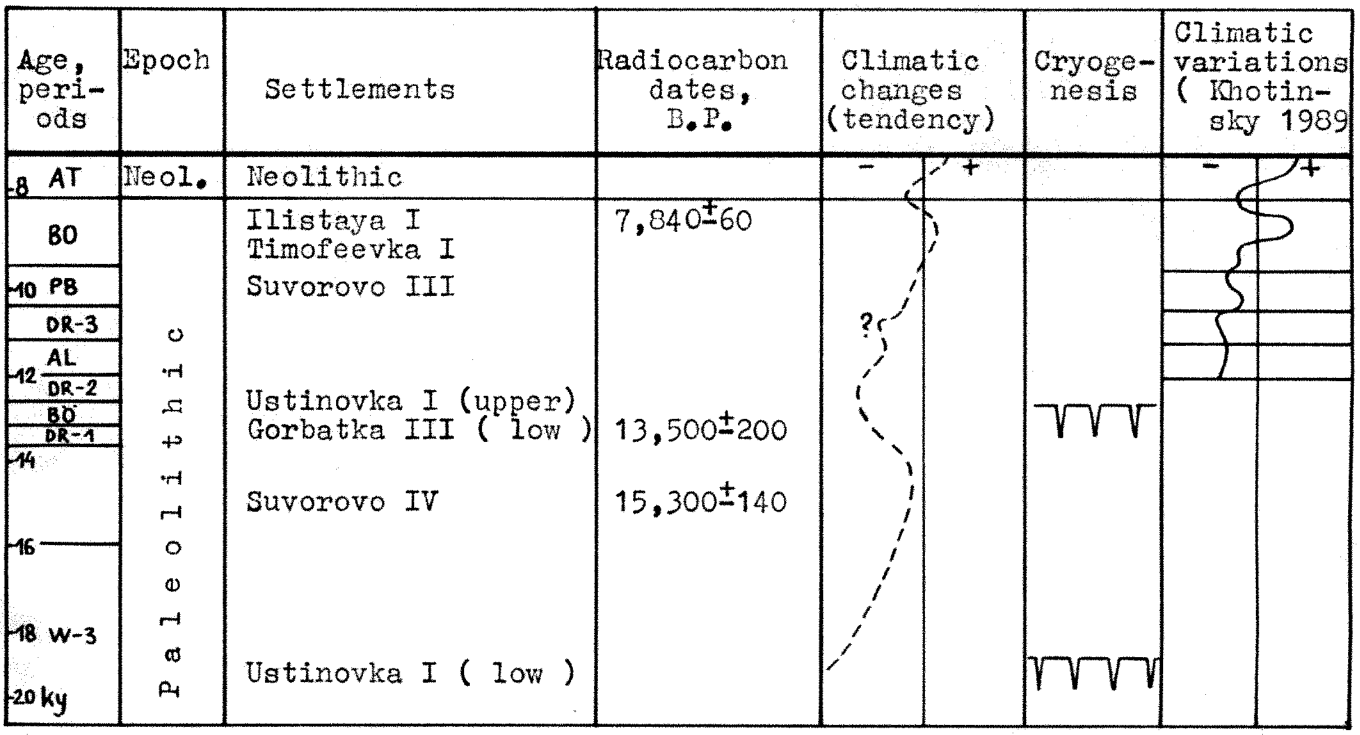
For Ilistaya I a pollen diagram was obtained (Fig. 5). In the Palaeolithic-Neolithic cultural layer (0.25-0.40 m in depth), arboreal pollen prevails (70-90%), while the amounts of non- arboreal pollen and spores are 10-20% and 7-10% respectively. Among the arboreal pollen, though *Betula* (27-60%) and *Corylus* (39-73.5%) dominate, *Alnus*, *Quercus*, *Pinus*, *Araliaceae*, are also found. In the composition of non-arboreal pollen, *Artemisia* (36-45%) and *Varia* (4-60.5%) prevail, but *Poaceae* (up to 12%) is also present. Among the spores, *Polypodiaceae* (54-80%) predominate.

A picture of the vegetation cover is, on the whole similar to that for the Timofeevka I site, thus making it possible to use this data for palaeogeographical reconstructions for the Ilistaya I site.

From the Final Palaeolithic layer in the Ilistaya I site (0.35-0.40 m), a radiocarbon date of 7,840-60 (Ki-3163) B.P. was obtained.

The location of the Gorbatka III site is analogous to that of Ilistaya I. The total thickness of deposit is 1.5-2 m (Fig. 6). The section is characterized by the presence of frozen textures and traces of solifluction soils in the deposits underlying the cultural layer.

Mineralogical analysis of Gorbatka III deposits indicates eluvial and, probably, deluvial genesis of the deposits. The pollen data obtained by Verkhovskaya (personal communication) concerning the upper layer of Gorbatka III, are on the whole, similar to data for Timofeevka I and Ilistaya I and reflect a similar picture of the vegetation



Age, periods	Epoch	Settlements	Radiocarbon dates, B.P.	Climatic changes (tendency)	Cryogenesis	Climatic variations (Khotinsky 1989
8 AT	Neol.	Neolithic		– +		– +
BO	Paleolithic	Ilistaya I Timofeevka I	7,840±60			
10 PB		Suvorovo III				
DR-3				?		
AL						
12 DR-2						
BÖ		Ustinovka I (upper)				
DR-1		Gorbatka III (low)	13,500±200			
14						
		Suvorovo IV	15,300±140			
16						
18 W-3						
20 ky		Ustinovka I (low)				

Fig. 7: Scheme of palaeogeographical conditions of the Late Paleolithic of Primorye (the former Far East USSR)

during prehistoric times. From the lens of organic material, in the sub-soil deposits of Gorbatka III a radiocarbon date of 13,500±200 B.P. (SOAN-1922) was obtained (Fig. 6).

A palaeogeographical study of the Final Palaeolithic sites — Ilistaya I, Gorbatka III and in particular, Timofeevka I — in the Ilistaya and Razdolnaya river valleys, shows that the vegetation during prehistoric times was represented by birch-hazel forests with an admixture of warmth-loving species (Amur cook, nut-tree and others). The radiocarbon data indicate an Early Holocene age for the majority of these sites. The data obtained are quite consistent with the general palaeogeographical picture of the Boreal period of the Holocene in Primorye (Korotky *et al.* 1980; Kuzmina *et al.* 1987). The lower layer of the Gorbatka III site is probably somewhat earlier and is dated to the Late Glacial period, 10,000-12,000 B.P. The upper layer of Gorbatka III, Ilistaya I, and Timofeevka I can be assigned to the Holocene-Boreal period: 8,000-9,000 B.P.

Conclusion

The data obtained on the palaeogeography and the chronology of the Late and Final Paleolithic sites in Primorye are schematically presented in Fig. 7. In general, the periodicity and chronology of the Palaeolithic cultures in Primorye, as compiled by the author, are given in the columns "Epoch", "Settlements" and "Radiocarbon dates", taking into account the archaeological data. Trends in climate change are indicated through the Palaeolithic and Neolithic periods in the course of the development of these ancient cultures. The complicated and, in many respects, inconclusive nature of the pollen spectra of these sites do not allow us to proceed to quantify indices. The column "Cryogenesis", represents the most striking natural phenomena reflected in the cultural layers of the sites presented. Therefore, for the Sartan period, in addition to the main phase of cryogenesis occuring c. 18,000-20,000 B.P., a cryogenesis phase related to the cooling in the Younger Drayas is identified. The column "Climatic variations" (Khotinsky 1989) presents the palaeoclimatic curve for the Holocene in the former Far East U.S.S.R., and is considered a reference point.

Acknowledgements

The author is indebted to Dr. Natalya B. Verkhovskaya, Dr. Anna V. Chernuk, Dr. Galina M. Shumova (palynological analysis), Dr. Tatyana N. Voskresenskaya (mineralogical analysis), and Drs. Luybov A. Orlova, Nikolai N. Kovalukh, Vadim V. Scripkin (radio carbon analysis). My thanks are also due to Professors Zhanna V. Andreeva, Ruslan S. Vasiljevsky and Nikita A. Khotinsky; Dr. Sergei A. Gladyshev, Dr. Anatoly M. Kuznetsov and Valery P. Stepanov for discussion of the material on which this paper is based. I am grateful to Victor Karpets for the translation of this manuscript into English and Maureen Carlson and Prof. Roy L. Carlson for correction of the manuscript.

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Quantitative Composition and Functional Aspect of the Palaeolithic Assemblages of Rock Shelter III F-23 at Bhimbetka

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Abstract

This study is the first attempt in India to assess the temporal variation in Palaeolithic assemblages recovered from a primary context.

Introduction

Bhimbetka (22° 55' 22° 56' N: 77° 36' 77° 37' E) is the name of a small hill on the northern margin of the Vindhyas in the Raisen district of Madhya Pradesh. It is situated 2 km southwest of Bhianpur, a tribal hamlet 45 km south of Bhopal and 30 km north of Hoshangabad between Obaidullaganj and Barkhera stations on the Central Railway (Misra 1978). The highway from Itarsi to Bhopal runs parallel to the railway line and passes close to Bhianpur. The Bhimbetka hill is connected to the highway by a link road from Bhianpur. On the top and slopes of this hill there are over 200 shelters of varying sizes. The majority of these shelters contain on their walls and ceilings paintings depicting scenes in the life of prehistoric hunter-gatherers and later agricultural societies as well as scatters of microliths on the floors and outside the mouths of these shelters. A small number of shelters also contain habitation deposits on their floors.

The site was discovered by the late V.S. Wakankar in 1957 (Wakankar 1975). In the following years he continued to explore the region and located a total of 754 rock shelters out of which over 500 contain paintings. Between 1972 and 1977 excavations were conducted in more than a dozen of these shelters by V.S. Wakankar (Vikram University, Ujjain), V.N. Misra (Poona University, Pune) and Susanne Haas (Museum für Volkerkunde, Basle). One of these shelters, III F-23 which was excavated by Misra produced a continuous cultural succession from the Lower Palaeolithic to the Mesolithic in a stratified and primary context. The maximum thickness of the habitation deposit encountered was 3.80 m, but this occurred only in trenches E and F out of the total of 8 trenches excavated in the shelter. Altogether eight layers were recognized. Layers 1,2 and 3 represent the Mesolithic period, layer 4 the Upper Palaeolithic, layer 5 the Middle Palaeolithic and layers 6, 7 and 8 the Lower Palaeolithic. From this excavation more than 1,00,000 stone artefacts from four cultural periods were recovered. From the Palaeolithic layers a total of 29,748 artefacts were found. Of these 18,721 (62.93%) belong to the Lower Palaeolithic, 8,505 (28.59%) to the Middle Palaeolithic and 2,522 (8.48%) to the Upper Palaeolithic. Misra classified the Palaeolithic artefacts using the typological scheme of François Bordes elaborated in his *Typologie du Paléolithique Ancien et Moyen* (Bordes 1961).

The present study is restricted to artefacts recovered from trenches E and F. These trenches were selected because they produced the thickest cultural deposit and provided a complete cultural sequence. The total number of artefacts from these two trenches was 11,536. A detailed quantitative analysis of the assemblages has been carried out. The artefacts have been grouped into two broad categories: (1) shaped tools and (2) simple artefacts. Shaped tools are those artefacts which show deliberate human workmanship including secondary retouch or edge trimming which may or may not significantly alter the primary form of the artefact. Simple artefacts are by-products or remnants of intentional flaking which may or may not show the evidence of utilization and/or minor modification and which do not fit into any tool class. Though the Levallois flake is classified as a shaped tool in Bordes' scheme, in this study it has been included in the category of simple artefacts.

The chi-square test has been employed to measure the significance of the variation in the assemblages of different periods with respect to artefact type and artefact class (a broad group of similar artefact types). A few metric variables such as weight (g), length (mm), breadth (mm) and retouch angle (degrees) of the artefacts have been considered to determine the functional aspect of the artefact variants between and within the cultural periods (actually between

Table 1: Frequency distribution of artefacts in trenches E and F of rock shelter III F-23, Bhimbetka

Artefact Type	**Lower Palaeolithic**		**Middle Palaeolithic**		**Upper Palaeolithic**		**Total**	
	#	%	#	%	#	%	#	%
Shaped Tools								
Handaxes								
Lanceolate	2	0.08	—	—	—	—	2	0.06
Sub-Triangular	2	0.08	—	—	—	—	2	0.06
Amygdaloid	1	0.04	—	—	—	—	1	0.03
Elongated Cordiform	1	0.04	—	—	—	—	1	0.03
Sub-Cordiform	2	0.08	—	—	—	—	2	0.06
Oval	5	0.20	—	—	—	—	5	0.15
Limande	3	0.12	—	—	—	—	3	0.09
Cleavers								
Rounded Butt & Transverse Edge	2	0.08	—	—	—	—	2	0.06
Rounded Butt & Oblique Edge	3	0.12	—	—	—	—	3	0.09
Rounded Butt & Convex Edge	6	0.24	—	—	—	—	6	0.18
Pointed Long Butt & Oblique Edge	2	0.08	—	—	—	—	2	0.06
Pointed Long Butt & Convex Edge	1	0.04	—	—	—	—	1	0.03
Pointed Short Butt & Transverse Edge	1	0.04	—	—	—	—	1	0.03
Pointed Short Butt & Oblique Edge	3	0.12	—	—	—	—	3	0.09
Truncated Convergent Butt & Transverse Edge	1	0.04	—	—	—	—	1	0.03
Truncated Convergent Butt & Oblique Edge	6	0.24	—	—	—	—	6	0.18
Truncated Convergent Butt & Convex Edge	3	0.12	—	—	—	—	3	0.09
Non-biface Tools								
Simple Straight Side Scraper	122	4.89	30	4.29	—	—	152	4.68
Simple Convex Side Scraper	274	10.97	110	15.74	6	8.58	390	12.03
Simple Concave Side Scraper	236	9.49	72	10.30	1	2.22	309	9.53
Double Straight Side Scraper	3	0.12	2	0.29	—	—	5	0.15
Double Straight & Convex S. Scraper	12	0.48	2	0.29	—	—	14	0.43
Double Straight & Concave S. Scraper	7	0.28	3	0.43	—	—	10	0.30
Double Biconvex Side Scraper	15	0.60	3	0.43	—	—	18	0.55
Double Biconcave Side Scraper	16	0.64	3	0.43	—	—	19	0.58
Double Concave & Convex S. Scraper	33	1.32	2	0.29	1	2.22	36	1.10
Convergent Straight Side Scraper	13	0.52	3	0.43	—	—	16	0.49
Convergent Convex Side Scraper	23	0.92	3	0.43	—	—	26	0.80
Convergent Concave Side Scraper	16	0.64	1	0.14	—	—	17	0.52
Déjeté Side Scraper	79	3.16	30	4.29	—	—	109	3.36
S. Trans. S. Scraper	26	1.04	4	0.57	—	—	30	0.92
Convergent Transverse Side Scraper	60	2.40	11	1.57	1	2.22	72	2.22
Concave Transversal Side Scraper	24	0.96	3	0.43	—	—	27	0.83
Side Scraper with Ventral Retouch	171	6.85	27	3.86	2	4.44	200	6.17
Side Scraper with Steep Retouch	170	6.84	32	4.57	2	4.44	204	6.29
Side Scraper with Alternate Retouch	55	2.11	22	3.14	—	—	77	2.37
End Scraper	242	9.68	78	11.16	4	8.88	324	9.99
End Scraper & Side Scraper	40	1.60	23	3.29	—	—	63	1.94
Borer (Typ. & Atyp.)	35	1.40	8	1.14	2	4.44	65	1.38
Backed Knife (Typ. & Atyp.)	18	0.72	3	0.43	1	2.22	22	0.68
Knife with Natural Back	14	0.56	10	1.40	3	6.66	27	0.83
Truncated Flake	261	9.57	50	7.15	6	13.32	317	9.78

Artefact Type	**Lower Palaeolithic**		**Middle Palaeolithic**		**Upper Palaeolithic**		**Total**	
	#	%	#	%	#	%	#	%
Denticulate	156	6.24	66	9.44	4	8.88	226	6.97
Alternate Burinate Beak	3	0.12	—	—	—	—	3	0.09
Retouch on Ventral Face	—	—	—	—	2	4.44	2	0.06
Bifacial Retouch	2	0.08	—	—	—	—	2	0.06
Notch	250	10.00	74	10.58	9	20.00	333	10.27
Notch on End	78	3.12	24	3.43	1	2.22	103	3.18
Total	2498	77.05	699	21.65	45	1.30	3242	100
%	28.97	—	29.48	—	8.32	—	—	—
Simple Artefacts								
Lev. Flake (Typ.)	4	0.06	3	0.17	—	—	7	0.08
Lev. Flake (Atyp.)	8	0.13	6	0.34	3	0.60	17	0.20
Side Flake	723	11.80	129	7.71	21	4.23	873	10.52
End Flake	1155	18.85	238	14.23	67	13.51	1460	17.60
Indeterminate Flake	1171	19.12	374	22.37	15	3.02	1560	18.80
Blade	91	1.48	36	2.15	24	4.84	151	1.82
Microblade	6	0.09	4	0.24	7	1.41	17	0.20
Point	3	0.05	—	—	—	—	3	0.30
Chip	2649	43.24	797	47.66	354	71.37	3800	45.81
Lev. Flake Core	2	0.03	—	—	—	—	2	0.02
Discoidal Core	6	0.09	5	0.30	—	—	11	0.13
Globular Core	1	0.01	1	0.06	—	—	2	0.02
Prismatic Core	1	0.01	—	—	1	0.20	2	0.02
Pyramidal Core	3	0.05	—	—	—	—	3	0.03
Shapeless Core	303	4.99	79	4.72	4	0.80	386	4.65
Total	6126	73.86	1672	20.16	496	5.98	8294	100
%	71.03	—	70.52	—	91.68	—	—	—
Grand Total	8624	74.76	2371	20.55	541	4.89	11536	100

layers of different periods). For this purpose the distribution frequency and percentages, mean, standard deviation, coefficient of variation, 'Mann-Whitney U test' and 't test' were carried out to establish the suitability of the data for specific situations.

The Quantitative Composition of the Assemblages (Tables 1-2)

The quantitative analysis of the artefacts shows that there are variations in the artefact types among the three cultural periods. There is less variation between the Lower Palaeolithic and the Middle Palaeolithic than between the Middle Palaeolithic and the Upper Palaeolithic. In all there are 63 artefact types in the three periods. Of these 22 are common to all the three periods, 22 occur only in the Lower Palaeolithic, 17 occur only in the Lower Palaeolithic and the Middle Palaeolithic, one occurs only in the Lower Palaeolithic and the Upper Palaeolithic and one occurs only in the Upper Palaeolithic.

Variation is also seen in terms of frequency and percentages of artefact types. In the Lower Palaeolithic 28.97% of the artefacts are shaped tools and 71.03% are simple artefacts i.e. the proportion of shaped tools to simple artefacts is 1:2.47. Among shaped tools, bifaces constitute only 1.76% and the proportion of cleavers to handaxes is 1.75:1. Among handaxes the oval shaped handaxe is the most common type (31.25%). Other types are the limande (18.75%), lanceolate (12.50%, sub-triangular (12.50%), sub-cordiform (12.50%), amygdaloid (6.25%) and elongated cordiform (6.25%). Among cleavers, the rounded butt with convex edge and the truncated convergent butt with oblique edge (each 21.42%) are the commonest types. The truncated convergent butt with convex edge and pointed short butt with oblique edge each constitute 10.71%. The rounded butt

Table 2: Frequency distribution of artefact classes from trenches E & F of rock shelter III F-23, Bhimbetka

Artefact Class	**Lower Palaeolithic**		**Middle Palaeolithic**		**Upper Palaeolithic**		**Total**	
	#	**%**	**#**	**%**	**#**	**%**	**#**	**%**
			Shaped Tools					
Handaxes	16	0.64	—	—	—	—	16	0.49
Cleavers	28	1.12	—	—	—	—	28	0.86
Side Scrapers	1355	54.24	363	51.93	13	28.00	1731	53.39
End Scrapers	282	11.28	101	14.44	4	8.90	387	11.93
Borers	35	1.40	8	1.14	2	2.45	45	1.38
Knives	32	1.28	13	1.85	4	8.90	49	1.51
Truncated Flakes	261	10.44	50	7.15	6	13.32	317	9.98
Denticulates	156	6.24	66	9.44	4	8.90	226	6.98
Notches	328	13.13	98	14.02	10	22.22	436	13.45
Others	5	0.20	—	—	2	4.44	7	0.21
Total	2498	77.05	699	21.56	45	1.39	3242	100
%	28.97	—	29.48	—	8.32	—	—	—
			Simple Artefacts					
Flakes	3061	49.96	750	44.86	106	21.37	3917	47.22
Blades	91	1.48	36	2.15	24	4.84	151	1.82
Microblades	6	0.10	4	0.24	7	1.41	17	0.20
Points	3	0.05	—	—	—	—	3	0.04
Chips	2649	43.24	797	47.66	354	71.38	3800	45.82
Cores	316	5.16	85	5.08	5	1.00	406	4.90
Total	6126	73.86	1672	20.16	496	5.98	8294	100
%	71.03	—	70.52	—	91.68	—	—	—
Grand Total	8624	74.76	2371	20.55	541	4.96	11536	100

with transverse edge and pointed long butt with oblique edge each constitute 7.14%. Of the other three types — pointed long butt with convex edge, pointed short butt with transverse edge, and truncated convergent butt with transverse oblique edge — each constitute 3.57% of the sample.

The low percentage of bifaces contrasts with the very high percentage of non-biface tools. Among the non-biface tools, side scrapers constitute the largest class (54.24%) and display the total range of types defined by Bordes (1961). In this class the principal artefact types are simple convex (10.97%), simple concave (9.49%), ventral retouch (6.85%), steep retouch (6.84%), simple straight (4.89%), déjeté (3.16%), convex transversal (2.40%) and alternate retouch (2.11%). Notches (13.13%) form the second largest artefact class, with the notch comprising 10.00% and the notch-on-end 3.13%. This is followed by the artefact class of end scrapers (11.28%), in which the end scraper population is 9.68% and the end and side scrapers constitute 1.60%. Other major types are the truncated flake (10.44%) and denticulate (6.24%). Borers account for 1.40% of the assemblage and the backed knife and knife with natural back represent 0.72% and 0.56%, respectively. Alternate burinate beak and bifacial retouch occur in very small percentages (0.12% and 0.08%, respectively). Among simple artefacts, flakes constitute the largest class, (49.96%) followed by chips (43.24%) and cores (5.16%). In the class of flakes, indeterminate flakes constitute the largest type (19.12%) followed by end flakes (18.85%) and side flakes (11.80%). Levallois flakes (typical and atypical) are very few in number (0.06% and 0.13% respectively). Blades, microblades and points too are poorly represented (1.48%, 0.09% and 0.05%, respectively). Among cores the major type is amorphous (4.99%). Other types (Levallois, globular, discoidal, pyramidal and prismatic) constitute only 0.17% each.

In the Middle Palaeolithic assemblage there is a change in the frequency percentages of both shaped tools and simple artefacts. The percentage of shaped tools marginally increases to 29.48% from 28.97% in the Lower Palaeolithic. But this pattern is not seen in respect of individual tool types. The percentages of 12 types increase and those of 16

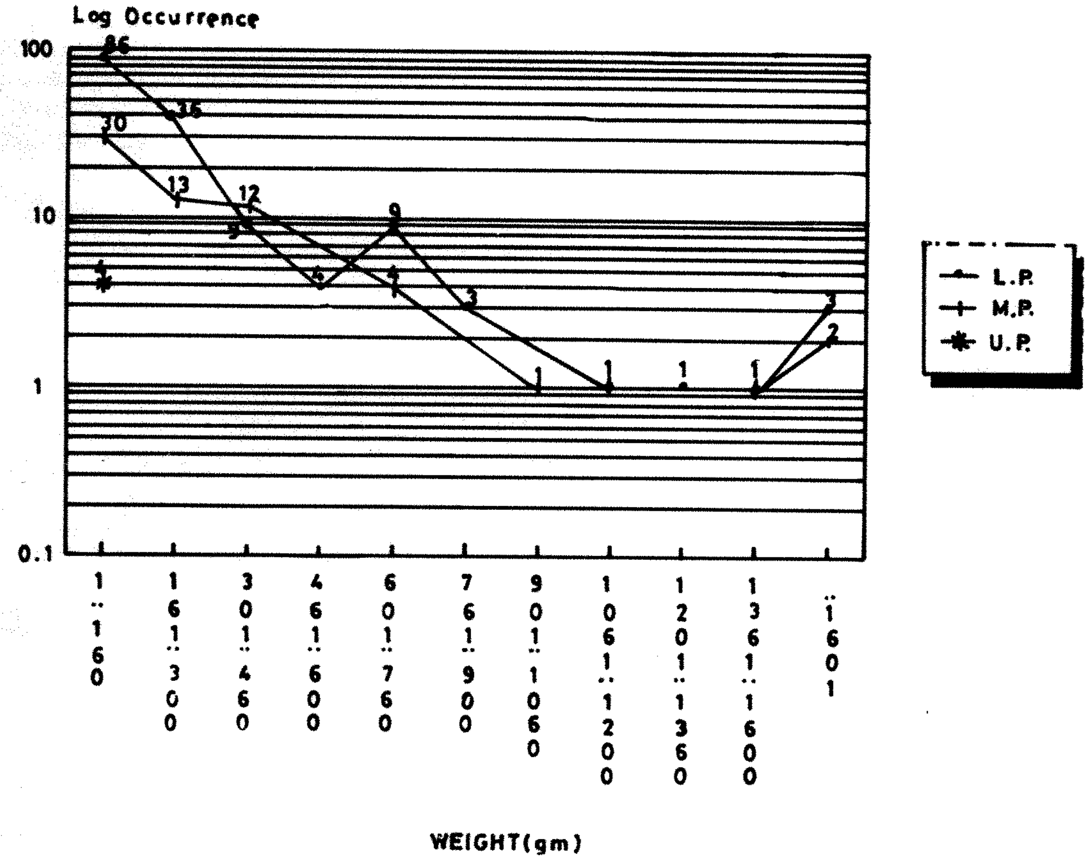

Fig. 1: Frequency distribution of weight of denticulates (period-wise)

types decrease from the figures obtained in the Lower Palaeolithic. The major types whose percentages increase are convex side scrapers, concave side scrapers, déjeté side scrapers, side scrapers with alternate retouch, end scrapers, knives with natural backs, notches and notches-on-end. On the other hand, the major types showing a decline in frequency percentages are truncated flakes, simple straight side scrapers, side scrapers with steep retouch and side scrapers with ventral retouch. Among the simple artefacts too a similar pattern prevails. The percentages of typical and atypical Levallois flakes, indeterminate flakes, blades, microblades, discoidal cores, globular cores and chips increase while those of side flakes, end flakes and amorphous cores decrease.

The Upper Palaeolithic assemblage is much smaller (4.69%) compared with the two earlier periods. Frequency percentages of shaped tools decline from 29.48% in the Lower Palaeolithic to 8.31% in the Middle Palaeolithic. The percentages of simple convex side scrapers, simple concave side scrapers, side scrapers with steep retouch, end scrapers, denticulates and notches-on-end decline. On the other hand, percentages of double concave and convex side scrapers, convex transversal side scrapers, side scrapers with ventral retouch, borers, backed knives, knives with natural back, truncated flakes and notches increase. Among simple artefacts the percentages of side flakes, end flakes, indeterminate flakes and amorphous cores decline; while there is a sharp increase in the percentages of atypical Levallois flakes (almost double), blades (more than double), microblades (more than six times) and chips (almost double).

Metrical Variables

Every artefact class in all the three cultural periods (in the Lower Palaeolithic and the Middle Palaeolithic in particular) as well as in every layer shows a small percentage of odd, extra heavy, large and thick artefacts which seem to distort the mean and produce an extra high standard deviation and co-efficient of variation. The frequency distribution tables and frequency curves display a wide range of variations indicating that the distributions are not normal; rather that they are highly skewed because of the occurrence of heavy artefacts. In these situations any interpretation based on mean value is not valid (Siegel 1956; Mian and Miyan 1984; Muhsin 1985). Hence the interpretation has been based on the modal value (i.e. the value which occurs most frequently or the position of the highest density in the distribution of data).

Weight

The mode of the weight curve of the handaxes is found in the third cell (class or group) (301-400) in the Lower Palaeolithic. In layer 8 there are two handaxes distributed in a scattered manner. In layers 7 and 6 the mode of the weight is seen in the third (301-400) and in the last cell (> 700), respectively. The modal value for the cleavers is in cell 401-500 in the Lower Palaeolithic. In layer 8 there is only one cleaver weighing 620 gm. In layers 7 and 6 modal weights appear in cells 401-500 and 201-300, respectively.

In all non-biface tools, with the exception of borers, as well as in flakes and cores the modal values occur in the first cell in all the periods (Figs. 1 and 2). Borers in the Upper Palaeolithic are an exception where two artefacts are distributed in a scattered manner. A similar pattern is observed in all the layers except 8, with respect to knives and flakes. There are only two examples of knives distributed in two cells. Among the flakes the modal value occurs in the second cell. The modal cell (the class or group where mode occurs) for all non-biface tools, except notches, is 1-150. For notches it is 1-50, for flakes 1-30, and for cores 1-500.

Blades show a bimodal distribution (in cells 6-10 and > 31) in the Lower Palaeolithic. In layer 8 the mode occurs in the last cell (> 31). In layer 7 the distribution is also multimodal. The dominant mode (the highest density) occurs in the last cell and sub-modes (the next highest density) in cells 6-10 and 16-20. Layer 6 shows a modal value in cell 6-10. In the Middle Palaeolithic the modes are scattered over three cells. In the Upper Palaeolithic the artefacts are scattered.

The number of microblades is very small. In the Lower Palaeolithic there are only two pieces, one each in layers 7 and 6, and each weighs 2 g. In the Middle Palaeolithic, two artefacts are distributed in a scattered manner. The modal weight in the Upper Palaeolithic is 2 g.

Chips show bimodal distribution in all the periods and in all the layers except 8. Dominant modes occur in cell 4-6 and sub-mode occurs in cell 10-12. In layer 8 the distribution is multimodal. Though a prominent mode occurs in the same cell (4-6), the sub- modes occur in two cells, 10-20 and 15.

The presence of a modal value in the first cell and a high frequency in the adjacent cells in all the artefact classes indicates that the assemblages are dominated by lighter artefacts.

Length

In the Lower Palaeolithic, handaxes showing a modal value of 18.75% occur twice, the first time in the lowest cell (81-90) and the second time in the middle cell (101-110). In layers 8 and 6 the artefacts are scattered. In layer 7 a modal value of 22.22% occurs three times in adjacent cells.

Cleavers also display bimodal distribution in the Lower Palaeolithic. The dominant mode occurs in the upper cell (141-150). In layer 8 one artefact has a length of 150 mm. In layer 7 the mode occurs in cell 131-140. In layer 6 a modal value of 33.33% occurs twice in cells 91-100 and 141-150. The high frequency in the cell adjacent to the upper modal cell indicates that this tool class is dominated by long (about 120 mm) tools.

For all non-biface tools (except borers and knives) as

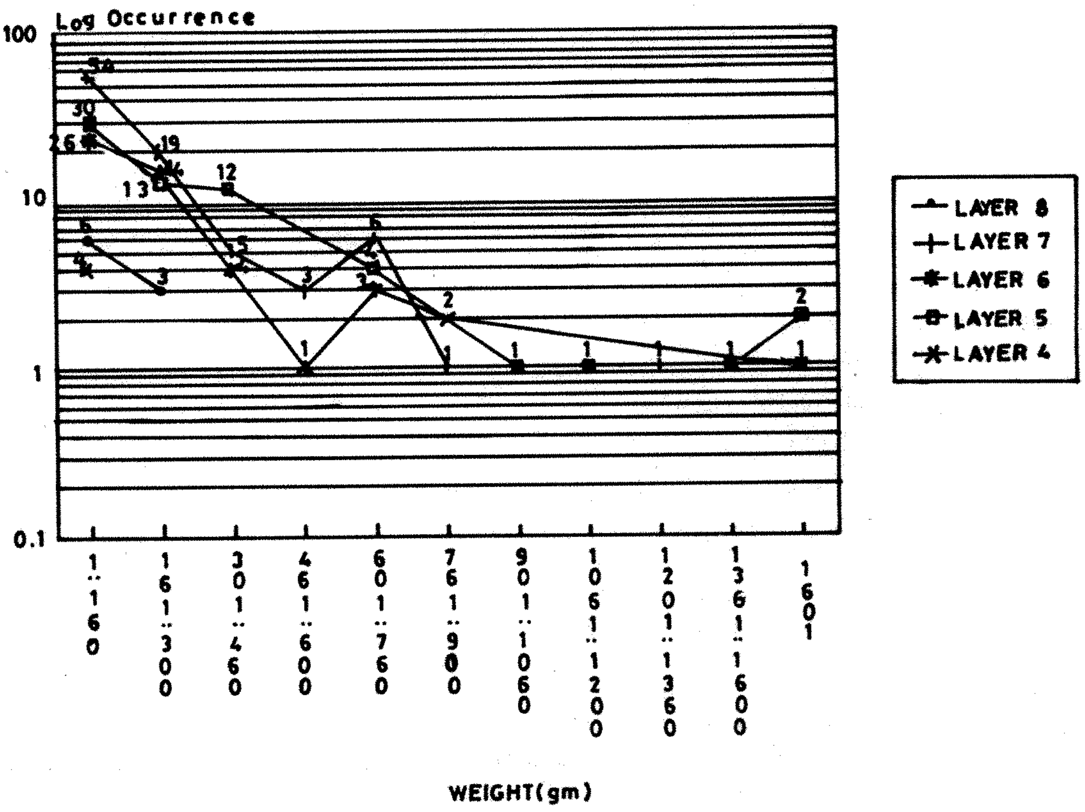

Fig. 2: Frequency distribution of weight of denticulates (layer-wise)

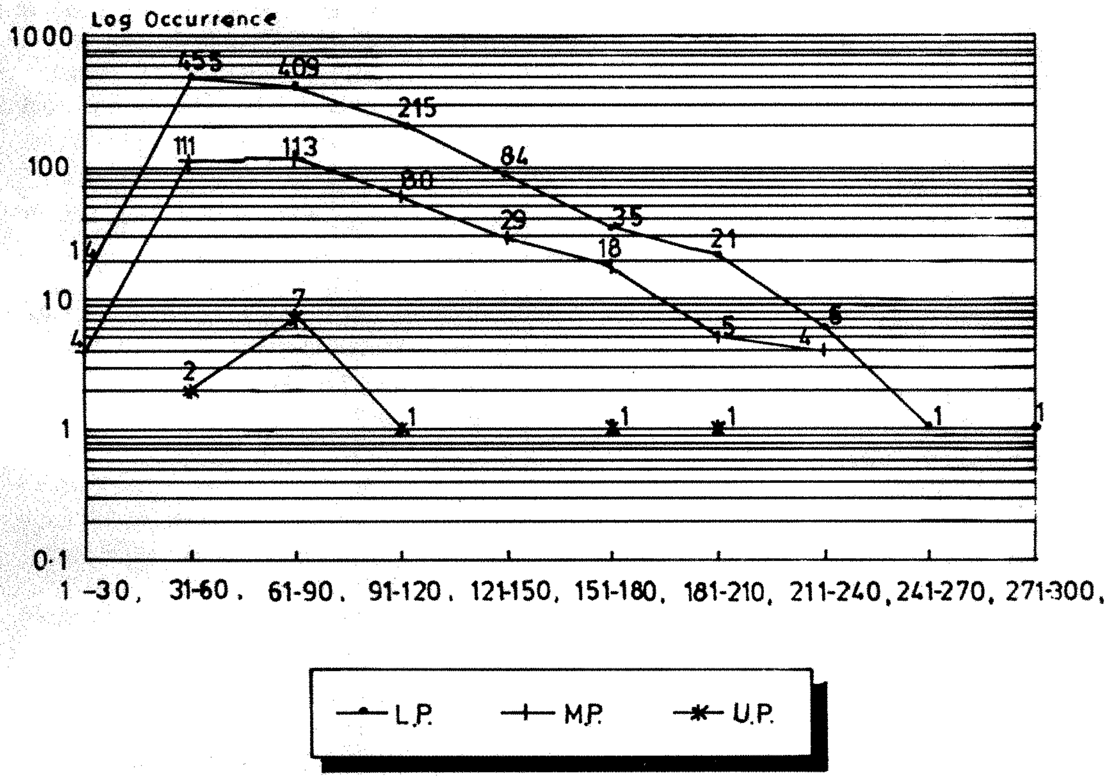

Fig. 3: Frequency distribution of length of side scrapers (period-wise)

well as for flakes and cores, the modal value appears in the second or third cells in all periods and layers. Apart from this the high frequency in the adjacent cells indicates that the assemblage is dominated by smaller artefacts (Figs. 3 and 4). These values correspond to those of weight. For all non-biface tools, except notches, the second and third cells are 31-60 and 61-90 respectively. For notches they are 21-40 and 41-60, for flakes 31-50 and 51-70, and for cores 51-80 and 81-110.

Borers display modal values in the second cell (31-60)

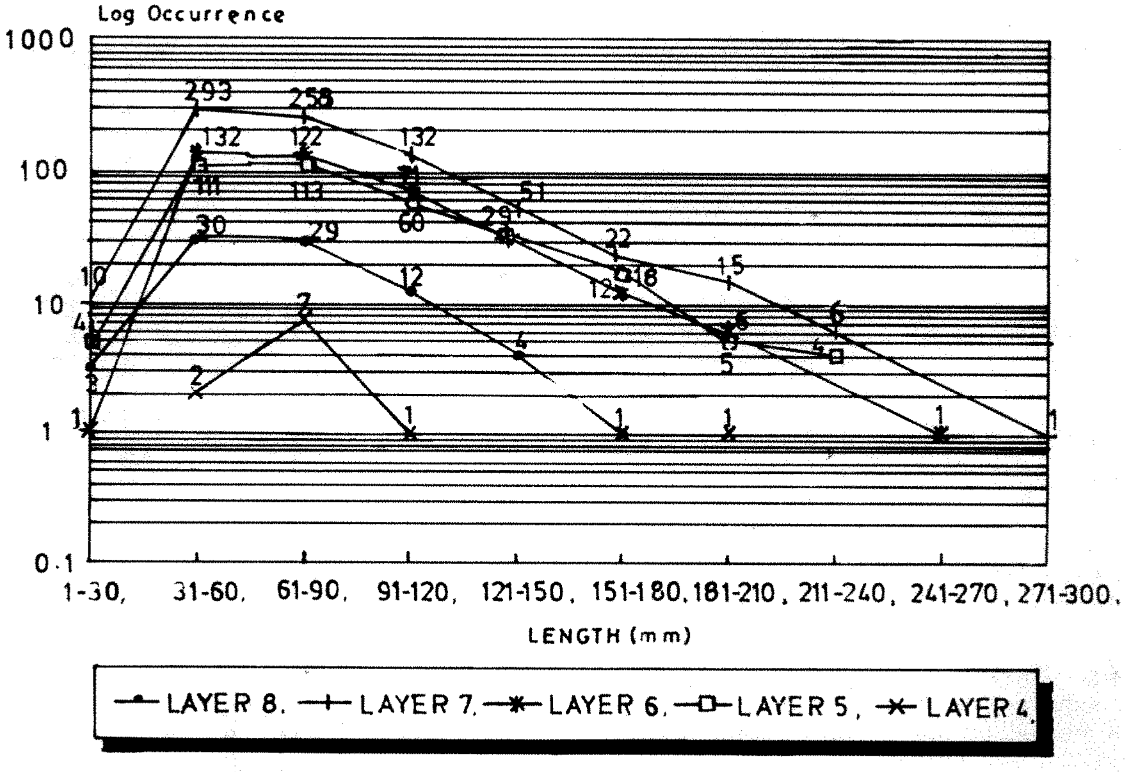

Fig. 4: Frequency distribution of length of side scrapers (layer-wise)

in the Lower Palaeolithic (in all the three layers) and in the Middle Palaeolithic. In the Upper Palaeolithic there are only two artefacts which are distributed in two adjacent cells (61-90 and 91-120).

In the case of knives a modal value of 28.13% is spread over two cells (61-90 and 121-150) in the Lower Palaeolithic. In layer 8 two artefacts are distributed in two adjacent cells. In layer 7 the mode appears in cell 61-90 and in layer 6 in cell 121-150. In the Middle Palaeolithic the modal cell is 61-90 whereas in the Upper Palaeolithic all artefacts occur in cell 31-60.

Blades display a bimodal distribution in the Lower Palaeolithic. The dominant mode occurs in the middle cell (51-60), while the sub-mode occurs in the last cell (71-80). In layer 8, the mode occurs in cell 71-80. In layer 7 the distribution is multimodal. The dominant mode occurs in cell 51-60 and two sub-modes occur in cells 71-80 and < 40 respectively. In layer 6 the distribution is also multimodal. The dominant mode occurs in cell 41-50 and sub- modes appear in cells < 40 and 71-80. In the Middle Palaeolithic and the Upper Palaeolithic the modes appear in cells 61-70 and 71-80 respectively.

Microblades show a modal value in the upper cell (21-30) in the Lower Palaeolithic. In layer 7 there is only one artefact and it has a length of 27 mm. In layer 6 the mode occurs in cell 21-30. In the Middle Palaeolithic there are two artefacts and they are distributed in two adjacent cells (11-20 and 21-30). In the Upper Palaeolithic the modal value lies in the first cell (11-20).

Chips show a modal value in the middle cell (31-35) in the Lower Palaeolithic (in all the layers). In the Middle Palaeolithic the mode lies in the next cell (36-40). In the Upper Palaeolithic the distribution is bimodal, the dominant mode occurring in the first cell (< 25) and the sub-mode in the upper cell (36-40).

Length also gives a more or less similar result. Length and weight are certainly correlated though not all that closely. The distribution of percentages shows that the assemblages in all the periods are dominated by smaller artefacts except for handaxes and cleavers. Among handaxes medium-sized tools are dominant while among cleavers large-sized tools are dominant.

Breadth

Handaxes show a modal value in the third cell (46-55) in the Lower Palaeolithic (Fig. 5). In the case of individual layers this is true only of layer 7 (Fig. 6). In layer 8 there are two handaxes in two different cells. Layer 6 shows a dominance of broader tools as the mode occurs in a higher cell (86-95).

Cleavers also show a dominance of medium-sized tools as the modal value occurs in the middle cell (66-75) in the Lower Palaeolithic in layer 7. In layer 8 only one broad cleaver occurs in cell 76- 80 and has a breadth of 82 mm. In layer 6 the modal value appears in two upper adjacent cells (66-75 and 76-85) indicating the dominance of broader tools.

In the case of side scrapers, end scrapers, truncated flakes, and flakes the modal values appear in the second cell (31-50) in all the cultural periods and in all the layers.

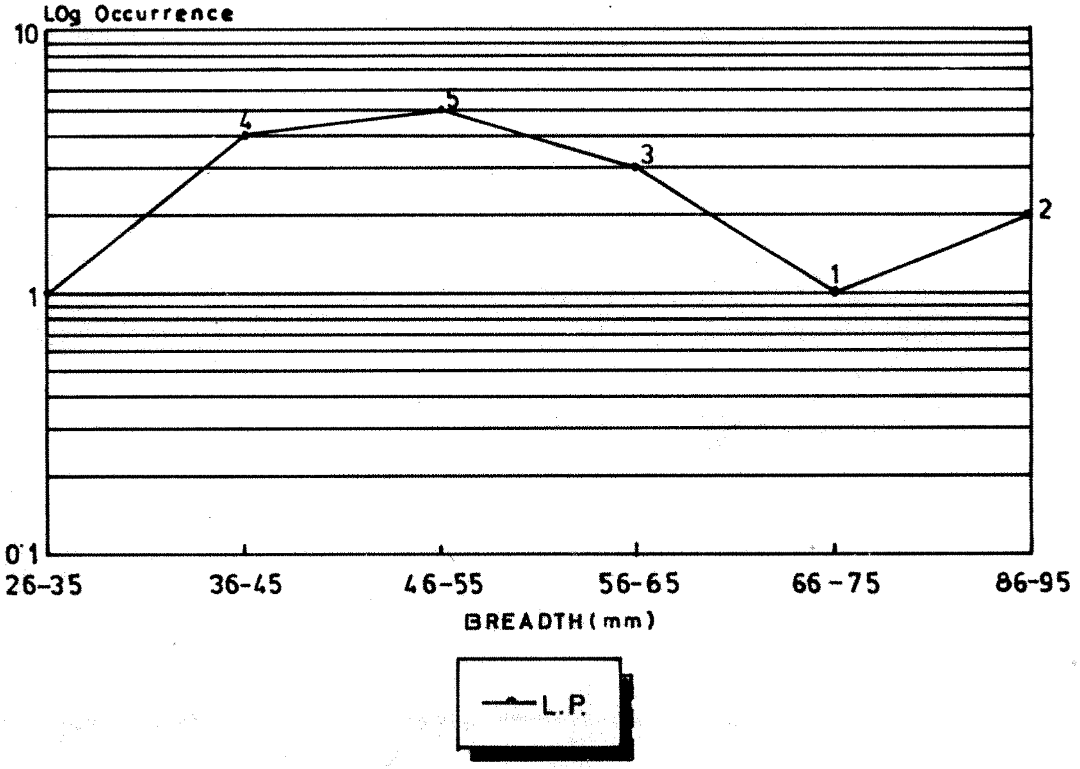

Fig. 5: Frequency distribution of breadth of handaxes (period-wise)

Table 3: Mean retouch angle of tool classes according to cultural period

Tool Class	Lower Palaeo-lithic	Middle Palaeo-lithic	Upper Palaeo-lithic
	Mean Retouch Angle		
Handaxes	70.62	—	—
Cleavers	57.93	—	—
Side Scrapers	81.73	78.84	80.42
End Scrapers	80.41	78.31	79.00
Borers	78.52	77.88	81.00
Knives	73.53	71.67	64.67
Truncated Flakes	83.35	81.08	73.50
Denticulates	78.37	76.25	79.75
Notches	80.89	78.88	72.10

Table 4: Mean retouch angle of tool classes in the Lower Palaeolithic according to layer

Tool Class	Layer 8	Layer 7	Layer 6
	Mean Retouch Angle		
Handaxes	79.00	67.88	72.20
Cleavers	60.00	58.05	57.17
Side Scrapers	84.15	81.91	80.89
End Scrapers	84.06	80.98	78.77
Borers	79.67	78.73	77.50
Knives	70.00	72.78	75.25
Truncated Flakes	81.67	83.89	82.33
Denticulates	77.94	78.59	78.03
Notches	85.88	80.87	80.12

Among borers the modal value appears in the second cell in the Lower Palaeolithic (layers 7 and 6). In layer 8 the artefacts are scattered. In the Middle Palaeolithic the modal value also occurs in the second cell. In the Upper Palaeolithic the artefacts are distributed in a scattered manner.

Knives show modal values in the second cell (31-50) in the Lower Palaeolithic (layer 7). In layer 8 the artefacts are spread over two adjacent cells (31-50 and 51-70). In layer 6 modal values are spread over two middle cells (31-50 and 51-70). In the Middle Palaeolithic the modal value occurs in cell 51-70, indicating the dominance of broader tools. The Upper Palaeolithic shows the dominance of narrower tools as the modal value occurs in the first cell (10-30).

Denticulates display a modal value in the second cell (31-40) in the Lower Palaeolithic (in all layers). In the Middle Palaeolithic the distribution is bimodal. The dominant mode occurs in the second cell and the sub-mode occurs in the fourth cell (71-90). In the Upper Palaeolithic the mode appears in the second cell.

Notches display a modal value in the second cell (31-40) in the Lower Palaeolithic (layer 8). In layer 7 the mode occurs in the preceding cell (21-30). Layer 6 shows a bimodal distribution, the principal mode occurring in cell

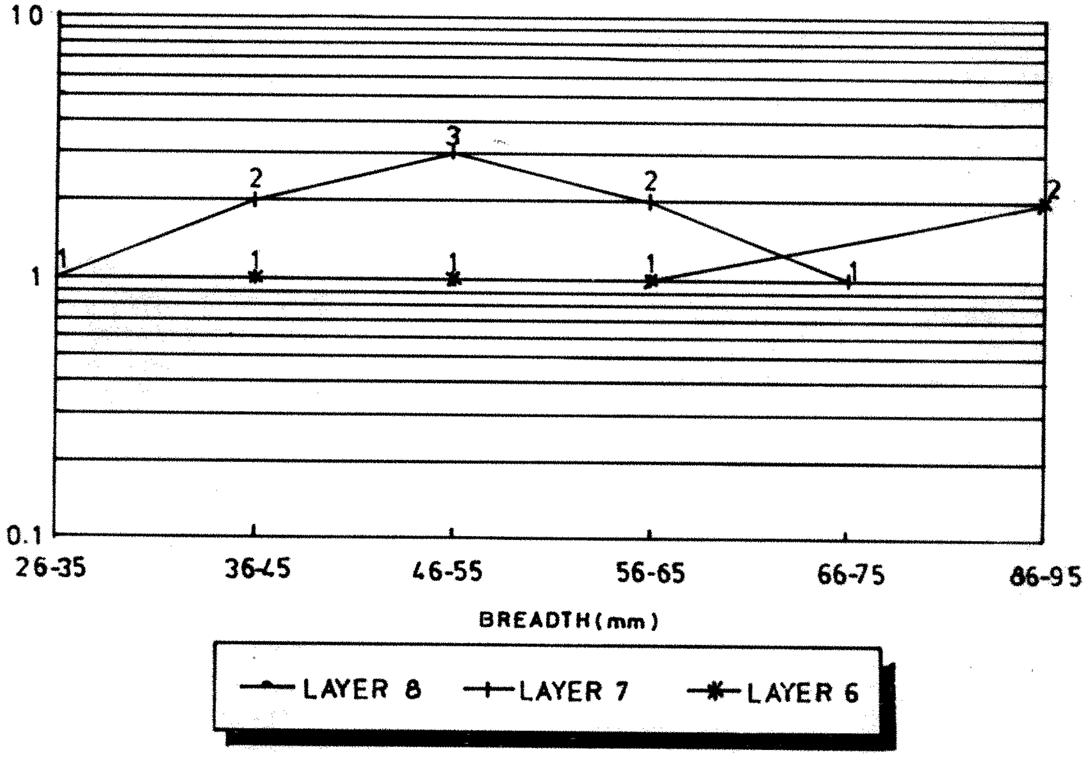

Fig. 6: Frequency distribution of breadth of handaxes (layer-wise)

31-40 and the sub-mode in cell 51-60. The Middle Palaeolithic also shows bimodal distribution with the principal mode occurring in cell 41-50 and the sub-mode in cell 21-30. In the Upper Palaeolithic the modal value lies in cell 41-50.

Blades display a modal value in the first cell (21-30) in all the periods and in all the layers except layer 8 where the value occurs in the second cell (31-40).

Microblades display a modal value in the last cell (12-15) in layer 6 of the Lower Palaeolithic. In layer 7 there is only one artefact and its breadth is 12 mm. In the Middle Palaeolithic the two artefacts are distributed in the first two cells. In the Upper Palaeolithic microblades are narrower as their modal value lies in the first cell (4-7).

Chips display a multimodal distribution in all the periods and in all the layers. In layers 7 and 6 of the Lower Palaeolithic the principal mode occurs in the first cell (< 20) and sub-modes in cells > 30 and 25-26 respectively. In layer 8 the principal mode occurs in the last cell whereas sub-modes occur in cells < 20 and 27-28. In the Middle Palaeolithic the principal mode occurs in the first cell and sub-modes in cells > 30 and 27-28. In the Upper Palaeolithic the principal mode appears in the first cell and sub-modes in cells > 30 and 25-26.

Among cores the modal value appears in cell 36-55 in layer 7 in the Lower Palaeolithic. In layer 8 the modal value lies in the next cell (56-75). In layer 6 the distribution is bimodal, the prominent mode being in cell 36-55 and the sub-mode in > 196. In the Middle Palaeolithic the modal value occurs in the second cell (36-55). In the Upper Palaeolithic the modal breadth is seen in cell 56-75.

In respect of breadth the assemblages show results similar to those of weight and length. Throughout the Palaeolithic the assemblages are dominated by narrower artefacts in all classes, with the exception of handaxes and cleavers, and in all periods. Handaxes and cleavers show a dominance of medium-broad and broader tools respectively.

Angle of Retouch

The retouch angle of all artefact classes, irrespective of the cultural period and layer, shows a moderately strong central tendency. Therefore in this study the interpretation has been made on the basis of the mean (Tables 3 and 4).

Among the handaxes in the Lower Palaeolithic the mean retouch angle is 70.62°, the highest (79°) occurring in layer 8 and the lowest (67.88°) in layer 7. In layer 6 it shows a medium angle (72.20°).

Among all the artefact classes, cleavers show the lowest mean retouch angle (57.92°) in the Lower Palaeolithic. The mean value gradually decreases from layer 8 (60°) through layer 7 (58.04°) to layer 6 (51.16°).

In four of the non-biface tool classes (side scrapers, end scrapers, borers and denticulates) the mean retouch angle decreases from the Lower Palaeolithic to the Middle Palaeolithic and then increases in the Upper Palaeolithic. In the other three classes (knives, truncated flakes and notches) the mean value gradually decreases from the Lower Palaeolithic to the Upper Palaeolithic (Table 3). Within the Lower Palaeolithic the mean retouch angle of side scrapers, end scrapers, borers and notches gradually decreases from layer 8 to layer 6. Knives show an opposite trend, i.e. a gradual increase in mean retouch angle from layer 8 through layer 7 to layer 6. In the case of truncated flakes and denticulates the mean value increases from layer 8 to layer 7, and thereafter it decreases in layer 6. With notches, the mean angle steadily decreases from layer 8 to layer 6 (Table 4).

Bifaces show a medium retouch angle (51°-75° in the Lower Palaeolithic. Handaxes show a higher angle (70.02°) than cleavers (57.92°). In general non-biface tools (except for knives, truncated flakes and notches) show a steep retouch angle (76°-85°). Knives show a medium retouch angle in all the three periods.

Chi-square Test

Chi-square tests show that the differences in the frequency percentages among various artefact types and artefact classes in the Palaeolithic assemblages are significant at 0.01 level of significance at a given degree of freedom.

Two Samples Analysis

Significance tests were carried out for all the four variables (weight, length, breadth, and retouch angle) in order to measure the significance in the difference between cultural periods and layers. Of these, for the first three variables where the distribution of data is skewed, a Mann-Whitney U test has been carried out. In the case of retouch angle where the data is normally distributed, a 't test' has been carried out. For each variable these tests have been done in four steps. In the first step, the samples of the Lower Palaeolithic and the Middle Palaeolithic have been compared. In the second step, a comparison of the samples from the Middle Palaeolithic and the Upper Palaeolithic has been undertaken. In the third step, the samples between layers 8 and 7 of the Lower Palaeolithic, and in the fourth step, the samples between layers 7 and 6 of the Lower Palaeolithic have been compared. As the samples of layers 5 and 4 and those of the Middle Palaeolithic and the Upper Palaeolithic are identical, these have not been analysed. The assumption behind these tests is that if there are significant differences between the samples of two cultural periods and/or two layers at 0.05 level of significance at a given degree of freedom, then there may be functional differences in the case of weight, length, and breadth between cultural periods and layers. In the case of retouch angle it is assumed that if the angles between the samples of two periods and/or layers show significant differences at 0.05 level of significance at a given degree of freedom, and if they (retouch angles) belong to two distinct groups (of < 55 and > 60), there are functional differences between two periods and/or layers (Fergusson 1980: 56-80). The results of these significance tests with respect to artefact classes are described below.

Handaxes and cleavers do not show any significant difference within the cultural period, i.e. between layers 8, 7 and 6 with respect to any variable.

Side scrapers suggest a significant difference between the Lower Palaeolithic and the Middle Palaeolithic on the basis of all four variables. They also show a significant difference within the Lower Palaeolithic. The difference is seen between layers 8 and 7 on the basis of one variable (retouch angle) and between layers 7 and 6 on the basis of two variables (breadth and retouch angle). No variable shows a significant difference between the Middle and Upper Palaeolithic.

End scrapers show a significant difference between the Lower Palaeolithic and the Middle Palaeolithic and within the Lower Palaeolithic between layers 7 and 6 on the basis of retouch angle only.

Among borers no variable is significantly different between the Lower and Middle Palaeolithic, whereas only one variable (length) shows a significant difference between the Middle Palaeolithic and the Upper Palaeolithic.

Knives do not show significant differences between the Lower Palaeolithic and the Middle Palaeolithic or within the Lower Palaeolithic with respect to any variable. On the other hand three variables (weight, length and breadth) display a significant difference between the Middle Palaeolithic and the Upper Palaeolithic.

Truncated flakes show significant differences in three variables (weight, length and breadth) between the Lower and Middle Palaeolithic. Within the Lower Palaeolithic only one variable (length) shows a significant difference between layers 8 and 7. Between layers 6 and 5 a significant difference is seen in three variables (weight, length and breadth). Between the Middle Palaeolithic and the Upper Palaeolithic significant differences are seen on the basis of all four variables.

Denticulates show a significant difference between the Lower Palaeolithic and the Middle Palaeolithic with respect to only one variable (retouch angle). No variable shows a significant difference within the Lower Palaeolithic. All other variables, except retouch angle, show a significant difference between the Middle and Upper Palaeolithic.

Notches show a significant difference between the Lower and Middle Palaeolithic and between layers 8 and 7 within the Lower Palaeolithic on the basis of one variable only (retouch angle). A significant difference is seen between layers 7 and 6 on the basis of the other three variables (weight, length, and breadth). Between the Middle and Upper Palaeolithic a significant difference is seen on the basis of retouch angle only.

Flakes show a significant difference between the Lower Palaeolithic and the Middle Palaeolithic and between the Middle and the Upper Palaeolithic with respect to three variables (weight, length and breadth). Between layers 8, 7 and 6 a significant difference is seen on the basis of one variable (weight). Two variables (weight and breadth) show a significant difference between layers 6 and 5.

Blades do not show significant differences between the three cultural periods. A significant difference is seen between layer 6 of the Lower Palaeolithic and layer 5 of the Middle Palaeolithic on the basis of one variable (weight) only.

Chips show significant differences between the Lower and Middle Palaeolithic on the basis of two variables (length and breadth). Between layers 8 and 7, a difference is seen in three variables (weight, length and breadth), and between layers 7, 6 and 5 in one variable (weight) only. Between the Middle Palaeolithic and the Upper Palaeolithic significant differences are seen on the basis of three variables (weight, length and breadth).

Cores display significant differences in three variables (weight, length and breadth) between the Lower and Middle Palaeolithic. A difference is seen between layers 8 and 7 in terms of weight, and between 7 and 6 in terms of length. Between layers 6 and 5 significant differences are seen with respect to two variables (weight and length). Between the Middle and the Upper Palaeolithic a significant difference is seen in length only.

Discussion

The analyses thus display differences, either significant or insignificant, within and between the cultural periods. The differences are significant in the case of the quantitative composition of the assemblages of three periods, namely the Lower, Middle and Upper Palaeolithic. Besides, the frequency distribution of four metric variables shows that by and large the assemblage within a cultural period is heterogeneous. In other words, the assemblage in each period consists of both smaller and larger, broader and narrower, thicker and thinner varieties of artefacts. What are the factors that produce these differences in artefacts and what is their significance? Here it is worth mentioning that morphometric analyses are concerned primarily with variation and only indirectly with its explanation (Roe 1973). Hence it is quite difficult to present any uncontroversial explanation for the variation among artefacts. Rather there has been considerable controversy on this subject over the last three decades. The most important of these arose from the interpretations offered for observed variations in the Mousterian of southwest France over functional variabilities and cultural traditions (Bordes 1961; Bordes and Sonneville-Bordes 1970; Collins 1969, 1970; Mellars 1970; Binford 1968, 1969, 1972, 1973, 1977, 1978, 1983; Binford and Binford 1966)

The variability revealed in rock shelter III F-23 may be due to (1) personality, i.e. motor habits of individual artificers; (2) medium, i.e. (a) raw material used, and (b) technology employed in the manufacture of tools; (3) function and (4) culture. However, the present paper attempts to explain the functional influence on the variation between the assemblages as it is revealed by the quantitative composition of the assemblages and by the analysis of four metric variables which are assumed to be responsible for functional variability. This variability can be explained in the following ways.

Variability in the Composition of the Assemblage

The large variety of artefact types in each period indicates that though they were used for different suites of activities at the site, it is difficult to assign positive functions to artefacts. Most likely one type was not used only for one purpose. Rather a great deal of overlapping between the functions of artefact types might have taken place (Bordes and Bordes 1970; Paddayya 1982). However, on the basis of experimental work (Semenov 1964; Keeley 1976, 1977, 1980), use-wear analysis (Keeley 1976, 1977, 1980), edge angle analysis (Kamminga 1976; Fergusson 1980), ethnographic parallels (Gould 1968, 1971; Carnerio 1979) and consideration of the environment of the site, it can tentatively be said that among the main activities performed by these tools were butchering, skinning, whittling, planing and shaping of wood, boring and throwing (of missiles).

It is more difficult to attribute functional influences to variations between two periods, because the appearance of new artefact types or the disappearance of old ones may not necessarily imply a change in activities. Rather, the same activity might have been performed by clearly different tool types (Mellars 1970). Thus the typological variability observed between the cultural periods may be explained in two ways. Either it is due to the influence of two different cultural traditions or it may be due to changes in activities. For instance, the disappearance of handaxes and cleavers in the Middle Palaeolithic may be due to the influence of two completely different cultures. If this assumption is valid then one has to accept that the tasks which were being performed by handaxes and cleavers in the Lower Palaeolithic were performed by other tool types such as large scrapers in the Middle Palaeolithic. In this context it is particularly relevant to recall Gould's observation (1968: 47) that the Western Australian aborigines effectively butchered large animals (kangaroos, euros, emus) with simple wooden wedges and stone flakes. In another observation on the Australian aborigines he notes, that "the large wood working scrapers are handled and are used as handaxes or scraper planes" (Gould 1971: 160-161). If this assumption is not valid then an alternative assumption, i.e. a change in activity, could be considered, though this seems rather weak.

As there is no indication of any drastic change in climate during the Pleistocene in peninsular India (S.N. Rajaguru, personal communication), it is assumed that flora and fauna similar to that of today existed in the Bhimbetka region throughout the Palaeolithic period. Besides handaxes and cleavers, six other types (alternate burinate beak, bifacial retouch, point, Levallois flake core, prismatic core and pyramidal core) are absent in the Middle Palaeolithic. But even in the Lower Palaeolithic these six types occur in a negligible proportion (Table 1). Besides, out of these six, four types are cores which are not important from the functional point of view. The other variation between these two periods is in terms of frequency percentages only. In the Upper Palaeolithic period 21 artefact types (besides handaxes and cleavers) are absent. But the artefact classes like side scrapers, end scrapers, borers, knives, denticulates and notches continue in this period. The major differences between this period and the preceding one is in the absence of 13 types of side scrapers and in the proportion of other artefact types (Table 1). This variation may be related to cultural influences. So it can be inferred that the presence of different artefact types in a period may be related to different suites of activities, and variation between two periods may be due to the influence of different cultures.

Metric Variation of Artefacts

Attributes of weight, length, breadth and the retouch angle are assumed to influence the functional variation in artefacts (though thickness is one of the components of dimensions, it has been treated as an indicator of refinement, i.e. technology).

The frequency distribution of artefacts according to weight, length and breadth shows that the assemblages in each period are dominated by lighter, smaller and narrower tools in terms of each artefact class, except for handaxes and cleavers. Handaxes and cleavers are dominated by medium-sized tools. In the other tool classes, medium-sized tools fall into the second category. Heavier, larger and broader tools are fewer in number in all the periods, particularly in the Upper Palaeolithic. This variation within a cultural period may be explained as being due to functional influence. Perhaps the heavier, larger and broader tools were used for heavy duty tasks, while the smaller, lighter and narrower tools were used for lighter ones.

The analyses of two samples reveal significant differences between layers 8, 7 and 6 in side scrapers, notches, flakes and chips in terms of one to three variables of dimension. This variation within the Lower Palaeolithic may be related to function.

Between two consecutive periods (Lower and Middle Palaeolithic, and Middle and Upper Palaeolithic) size varies significantly in side scrapers, knives and truncated flakes in respect of one of the three variables. In the case of side scrapers and truncated flakes this variation seems to be due to a morphological attribute (primary form) of the tool. For instance, 20% of the truncated flakes are made of natural rock pieces in the Middle Palaeolithic, while in the Lower Palaeolithic and the Upper Palaeolithic not a single example of this type is made on rock pieces. Knives show significant differences between the Middle Palaeolithic and the Upper Palaeolithic. In the Upper Palaeolithic the sample size in this class is too small (only 3) to draw any inference.

Variation is seen in the case of angle of retouch too, where it varies from 40° to 100° in different tool classes in different periods. The lowest retouch angle (40°-45°) is seen in cleavers and the highest (> 100°) in side scrapers and end scrapers. Based on experimental work and on ethnographic analogy, Fergusson (1980: 66-68) states "Each scraping implement will have an edge angle of over 55° ... and each cutting edge will have an edge angle below 60°". Though t tests show significant differences in retouch angle between some layers and periods in side scrapers, end scrapers, truncated flakes, denticulates and notches, the variation is not so extreme as to make the retouch angles of two different layers/periods fall into distinct categories i.e. > 55° or < 60°. For instance, in side scrapers the difference is statistically significant between the Lower Palaeolithic and the Middle Palaeolithic. The mean retouch angle in the Lower Palaeolithic is 79° whereas in the Middle Palaeolithic it is 82°. Similarly with end scrapers, the mean retouch angle is 80° in the Lower Palaeolithic and 78° in the Middle Palaeolithic. On this basis it can be inferred that both scraping and cutting activities were carried out in all the periods and so there may not have been a significant change in the activities during the three Palaeolithic periods. However, use-wear and experimental analysis may throw some more light on this aspect of Palaeolithic man's behaviour.

Conclusion

This study is the first attempt in India to assess the temporal variation in Palaeolithic assemblages recovered from a primary context. It has dealt with the artefactual material left by the Palaeolithic inhabitants of rock shelter IIIF-23 at Bhimbetka and covers the typological and functional aspects of artefact variants by a quantitative analysis of the artefacts and a few metric variables. The inferences drawn from the different analyses are by no means to be treated as conclusive but rather as interpretative suggestions which are summarized below:

1. There is variation in artefact types among the three periods. The variation between the Lower Palaeolithic and the Middle Palaeolithic is less than that between the Middle and Upper Palaeolithic. Handaxes, cleavers and six other artefact types are absent in the Middle Palaeolithic. In the Upper Palaeolithic, besides handaxes and cleavers, 21 other types are absent. The significant variation is seen in terms of frequency and percentage in artefact types in the different periods. However, there is some consistency in all the periods in terms of artefact classes with the exception of handaxes and cleavers (Tables 1 and 2).
2. The assemblages are heterogeneous in all the layers and periods. They are dominated by lighter, smaller and narrower artefacts in all classes with the exception of handaxes and cleavers. Handaxes and cleavers are dominated by medium sized artefacts. In general, heavier, larger and broader artefacts are more numerous in layer 7 of the Lower Palaeolithic. Similarly there are more artefacts in the Lower and Middle Palaeolithic than in the Upper Palaeolithic. Borers are heavier, larger and broader in the Upper Palaeolithic than in the preceding two periods.
3. A variety of activities like butchering, skinning, whittling, shaping of wood, hide scraping, skin cleaning, slicing, boring and throwing (missiles) might have taken place at the site and similar types of activities perhaps took place in all the three periods. There does not appear to have been any major change in activities throughout the Palaeolithic occupation of the site.

Acknowledgements

The Ford Foundation,Dhaka provided financial support for carrying out this research programme. The Deccan College, Pune provided computer facilities, and the Istituto Italiano per il Medio ed Estremo Oriente (IsMEO),Rome provided technical assistance and the computer software. We are grateful to Mr. V.C. Joshi and Dr. Charles R. Bailey of the Ford Foundation, and to Prof. Maurizio Tosi and Dr. Luca Bondioli of IsMEO for help in various ways. We thank Prof. B.K. Kale, Dr. S.D. Gore and Dr. R.P. Suresh of the Department of Statistics, University of Poona for their valuable help in carrying out statistical analyses.

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Mesolithic Human Burials in the Ganga Plain, North India

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Abstract

The Mesolithic hunter-gatherers were the first colonisers of the Ganga Plain to practise systematic disposal of their dead. This paper synthesizes several important aspects of the culture and presents evidence relating to their burial practices.

Introduction

The Ganga Plain has played a vital role in the development of the early history and culture of India. Archaeological research in the central part of this plain has pushed back the antiquity of human settlements to the terminal Pleistocene. More than 200 primary Mesolithic sites have been located in the middle and upper Ganga Plain (Fig. 1).

The middle Ganga plain was first colonized by groups of hunter-gatherers from the Vindhyan Plateau. Drained by the Ganga and its tributaries, the gently sloping plain is geomorphologically marked by abundant oxbow lakes of considerable extent and depth, and most of the streams originate in these lakes. Being rich in aquatic animals, these lakes and rivulets were extensively exploited by early man for his food. Communities inhabiting the banks of the lakes and rivulets also hunted elephant, rhino, bison and boar which were found here in abundance. As indicated by pollen analysis (Gupta 1976; Pant and Pant 1980), the area was covered by grassy vegetation. The existence of thick forests, including thorny bushes and trees, is suggested by the surviving patches of forests. These forests were also home to herbivorous animals like the deer, barasingha, nilgai and hare which were hunted by the people of the Mesolithic period. Edible fruits, roots, tubers and grains were also gathered from these forests.

The earliest Stone Age culture of the Ganga Plain, the Epipalaeolithic, is represented by six primary sites and marks the transitional phase between the Upper Palaeolithic and early Mesolithic cultures. Thin artefact-bearing horizons and the absence of any biological material, would suggest that these sites were only transit camps (Pal 1984). A few primary sites of the Mesolithic culture are marked by thick occupational deposits which are rich in cultural material and biological remains. Such sites mark the semi-sedentary Mesolithic settlements.

Excavations

The Mesolithic site of Sarai Nahar Rai in Pratapgarh District, was the first to provide evidence of the presence of human settlement in the Ganga Plain during the early Holocene period. The site was excavated in 1972 and 1973 by the Department of Ancient History, Culture and Archaeology, University of Allahabad (Sharma 1973,1975). Situated on the bank of a silted oxbow lake, the site covering an area of 1000 sq m contained a scattering of microliths, bone fragments, burnt clay pieces, etc. The major occupational deposit had been washed away leaving only a basal deposit of about 6 cm. However, excavations at the site revealed eleven graves, one with four burials and eight pit hearths, one of which yielded evidence of use in two phases and a hut floor (Sharma 1975).

Mahadaha is situated on the western bank of an ancient oxbow lake. It was brought to light in 1978 when work was in progress on a canal that passed through it. The canal has disturbed many of the skeletons especially towards its western embankment. Excavations in an area of 8000 sq m revealed a 60 cm thick occupation deposit which is divisible into four layers, each corresponding to a distinct cultural phase (Sharma *et al.* 1980). Stratigraphically, no gap is discernible in the formation of these layers. Besides the cemetery-cum-habitation area, excavations were also conducted in the lake and in the area where animals were butchered. Microliths, bone tools, querns, mullers and hammer stone fragments, rubbed hametite pieces and animal bones were recovered from the excavations. Of the structural remains, mention may be made of 35 oval or circular pit

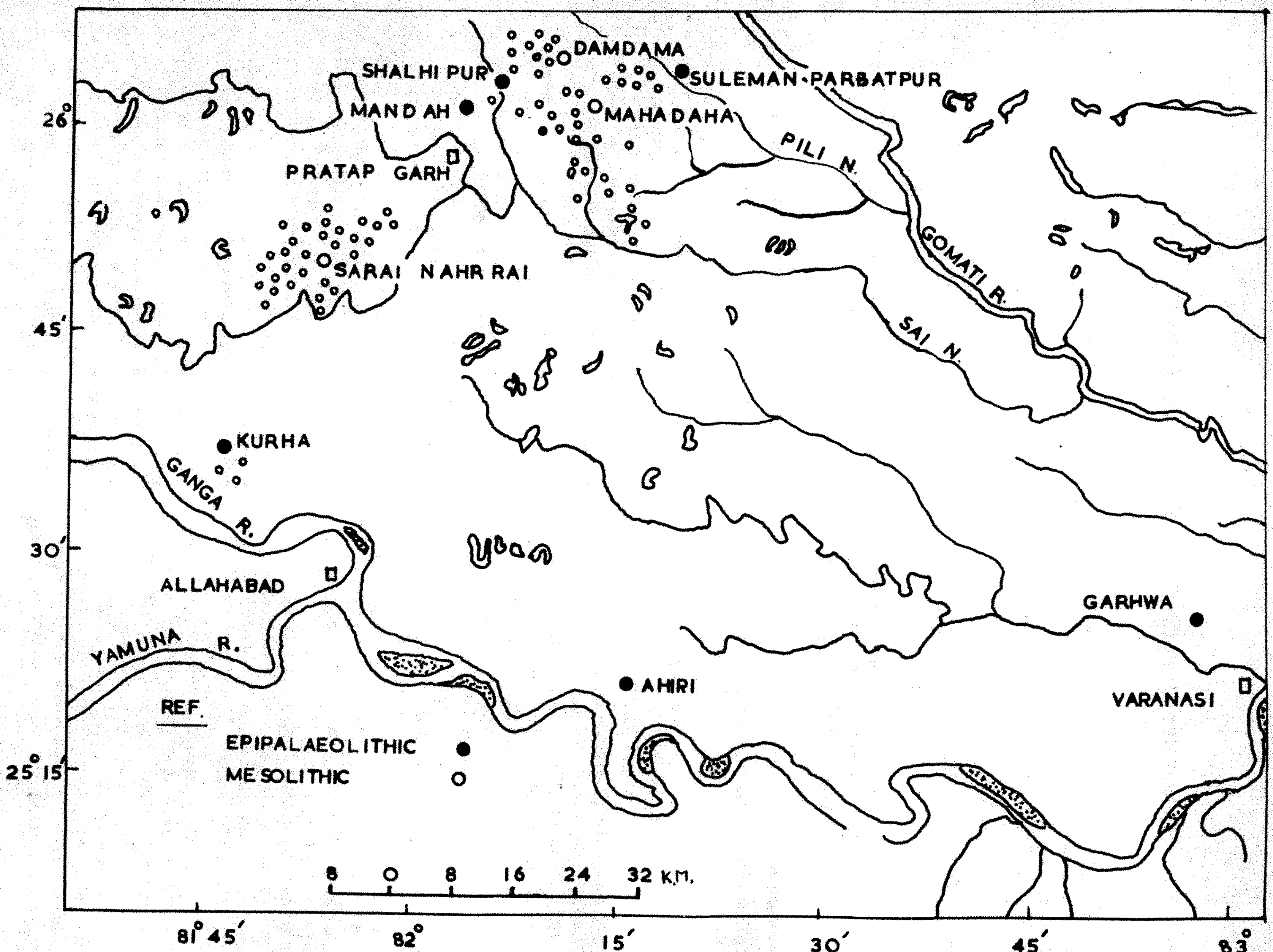

Fig. 1: The distribution of Mesolithic sites in the Ganga Plain

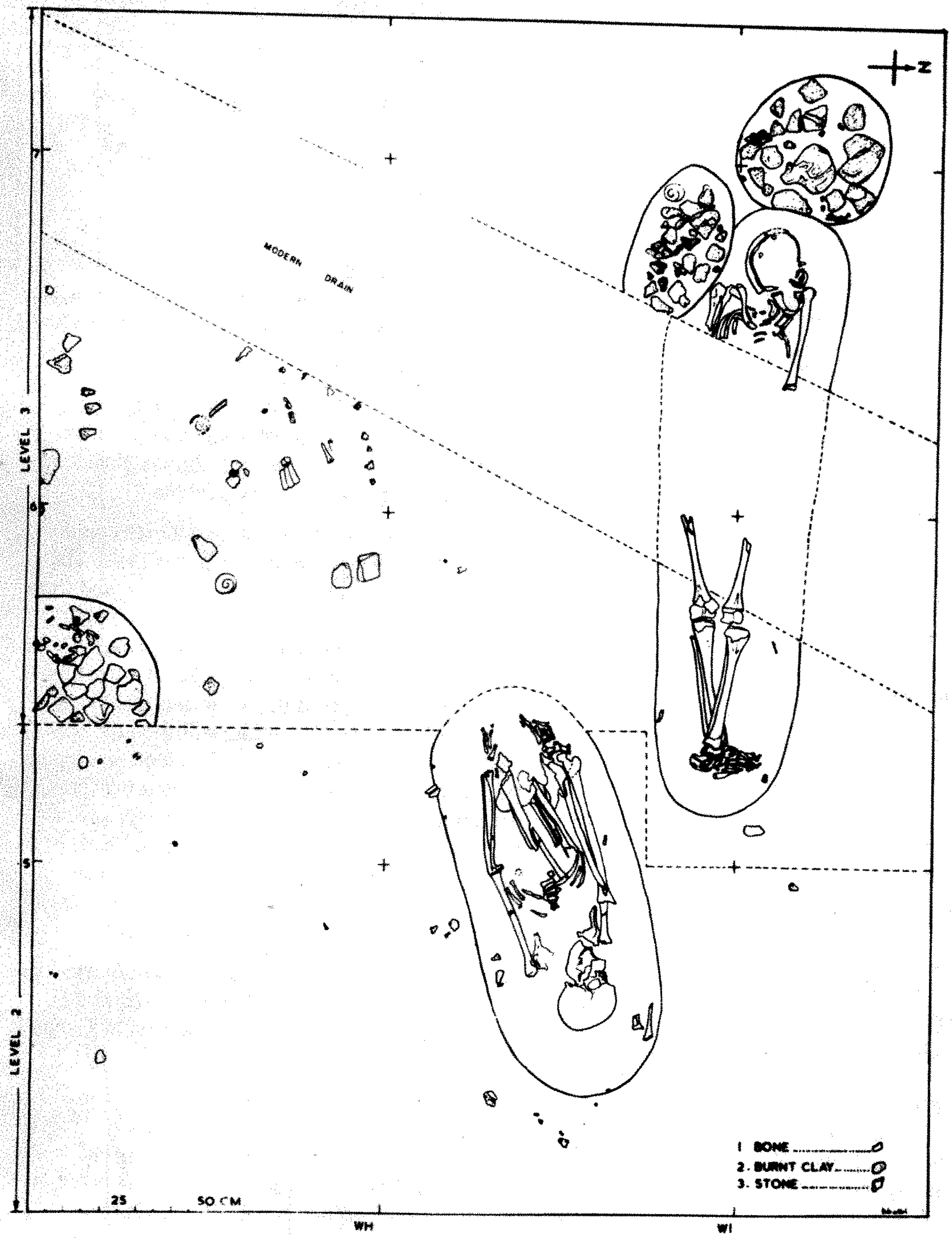

Fig. 2: The distribution of artefacts along with hearths and human burials

hearths, several patches of burnt floors/plaster and 28 human graves (Pal 1985).

The most recently excavated Mesolithic site in this area is that of Damdama. It is situated on slightly raised ground at the confluence of two branches of the Tambura nala, a tributary of the Pili which discharges itself into the river Sai (Varma *et al.* 1985). The excavations covered an area of 8750 m^2 and brought to light a habitation deposit of about 1.5 m, which is divisible into ten layers. The topmost layer represents the post-Mesolithic period. The rest of the layers correspond to different phases within the Mesolithic, though there is no interruption in the stratigraphy (Varma *et al.* 1985). Five seasons of excavations at the site have brought to light many important features of Mesolithic settlement in the Ganga Plains. Pit hearths (both plastered and plain), burnt plastered floors and 41 human graves were exposed at the site (Figs. 2 and 7). Other artefacts associated with different phases of the Mesolithic culture at the site include: microliths, bone objects, querns, mullers, hammer stones-cum-anvils, burnt clay lumps, charred grains and animal bones.

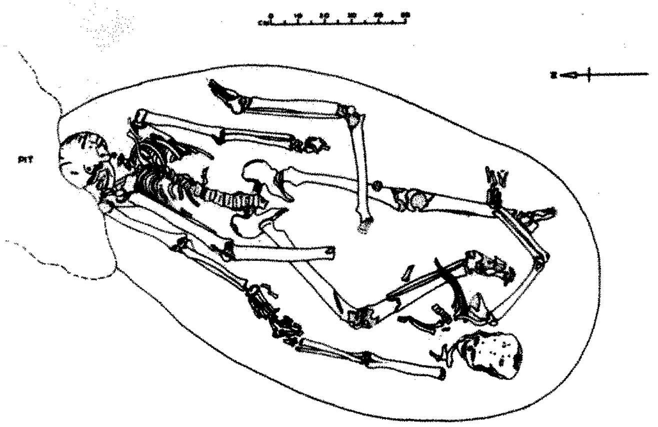

Fig. 3: A double burial at Damdama, Grave no. VI (opposite direction)

General Features of the Culture

Bones of the swamp deer and the hog deer found at these sites indicate several hunting seasons within a year, while the occurrence of rodent remains also suggests occupation at the sites of Mahadaha and Damdama (Chattopadhyay 1988: 140).

The microlithic industry (Pal 1986) consisting of retouched blades, including blunted-backed and truncated pieces, different types of scrapers, points, awls, triangles, and trapezes, not only indicate the use of the bow and arrow, but also sickles and harpoons which were utilized for collecting wild fruit, tubers, grains, and for fishing. The proximity of the oxbow lakes, nalas and streams facilitated the exploitation of aquatic animals such as fish and turtles, the bones of which have been excavated. Many of the excavated bird bones may have belonged to species that inhabited streams and rivers. Some of the blade tools exhibit a glossy polish on their working edge suggesting that they may have been used for cutting plants and grasses. The drills were used for making perforations in the bone objects. The tapering ends of bone arrowheads indicate that one end was hafted to a wooden shaft while the more pointed and sharper end served as the working point of the arrowhead.

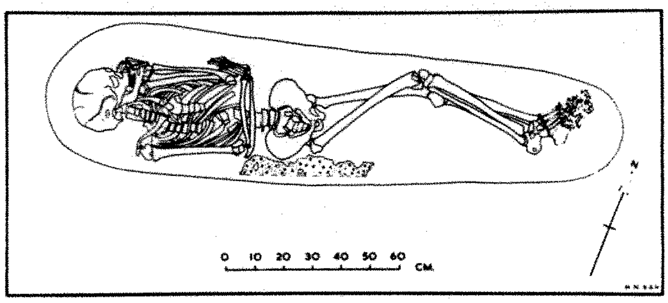

Fig. 5: An extended human burial at Damdama, Grave no. XXXVIII

A concave bone object with two perforations and a shining surface was possibly part of a quiver used for carrying arrowheads during hunting expeditions. Sometimes arrowheads were also fashioned from quartzite.

Pit hearths are one of the most important structural remains of the Mesolithic culture of the Ganga Plain. The oval or circular hearths were sometimes plastered, and were probably used for storing cooked food. Most of the pit hearths have been filled with burnt clay lumps, charred bone fragments and ash. The clay lumps facilitated the roasting of animal flesh. It is quite possible that there was one hearth per family unit. The distribution of pit hearths on the sites indicates that the hearth areas functioned as food processing and cooking areas as well as artefact manufacturing areas. The people sitting around the hearth during winter ate roasted flesh. The discovery of tiny fragments of charcoal at Damdama indicates that wood was also used as fuel, in addition to grass and leaves. However, the open pit hearths did not permit the larger pieces of charcoal to survive.

On the basis of a few ^{14}C dates, and on certain typological considerations, a time span of 8000 B.C. to 2000 B.C. has been proposed for the Mesolithic cultures of the Ganga Plain (Misra 1977; Varma 1987).

Human Burials

The human burials at Sarai Nahar Rai, Mahadaha and Damdama have shed light on Mesolithic burial practices, as well as on religious beliefs and rituals. In addition, the burials have provided information on dietary behaviour,

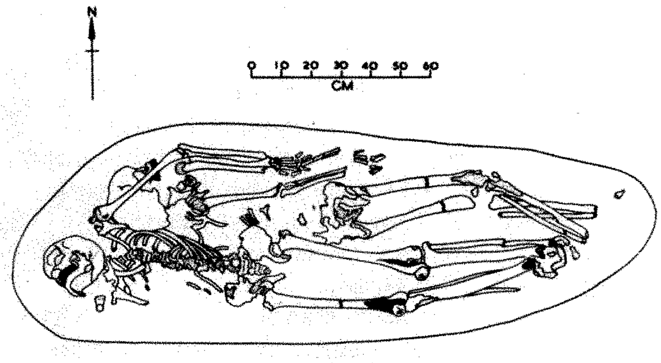

Fig. 4: A double burial at Damdama, Grave no. XXX

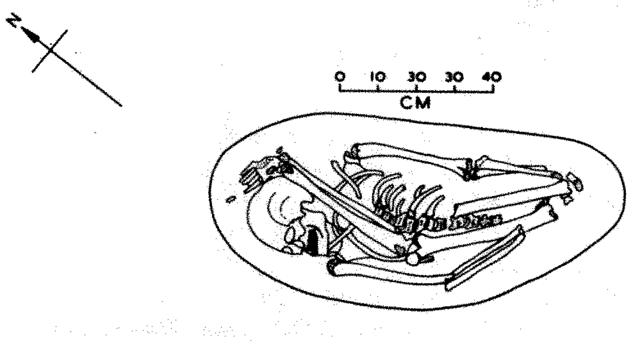

Fig. 6: A flexed human burial at Damdama, Grave no. XXVIII

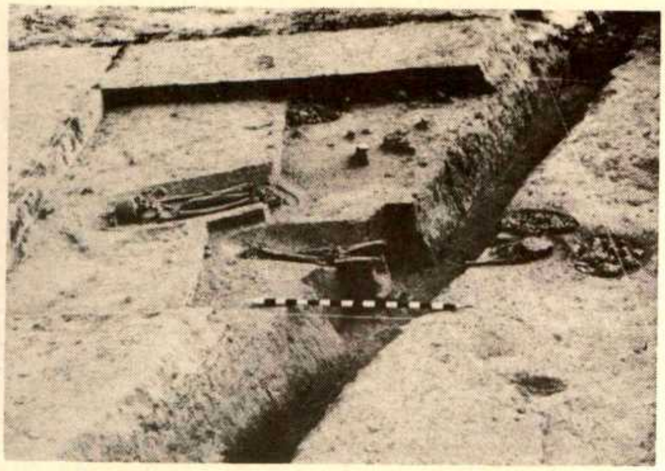

Fig. 7: Damdama: distribution of artefacts along with hearths and human burials

palaeopathology, and the social status of the people. Subsequently, in the historical period the method of the disposal of the dead in this area changed from burial to cremation. Only in exceptional cases, as in the case of children and death caused by cowpox, were the dead buried away from the settlement on the banks of lakes. In such cases, the corpse was oriented in a north-south direction. The Mesolithic burial practices seem totally different from those of subsequent periods.

Burials at Sarai Nahar Rai

Although the first human skeleton at Sarai Nahar Rai was excavated by the Anthropological Survey of India (Dutta 1971), the real nature of the burials and other details of the Mesolithic culture at the site were properly understood only after the excavations conducted by the University of Allahabad in 1972 and 1973 (Sharma 1973,1975).

The excavations at Sarai Nahar Rai revealed 14 human burials in eleven graves. As the overlying deposit at the site was washed away, these burials represent the earliest phase of the culture at the site.

All the graves were shallow and oblong and the dead were placed in an extended and supine position. In every case one hand was lying by the side of the body and the other was placed across the abdomen. The orientation of the skeleton was from west to east, with the skull pointing to the west. The graves were carefully prepared by being provided with a 3-4 cm thick, soft cushion of soil. The graves were filled up with earth and with refuse from the hearth. Among the grave goods, mention may be made of the microlithic tools and animal bones.

Barring Grave no. VII, each of the other graves contained a single skeleton. Grave no. VII (Fig. 8) was intentionally widened to receive four individuals which were buried at the same time. Two of these skeletons belong to males, while the other two have been identified as female. It is interesting to note that the males were placed to the right of the females. Even today, Hindu rituals unrelated to disposal of the dead require husbands and wives to be positioned in a similar manner.

Except for the skeleton in Grave no. II, which seems to be that of a child, most of the skeletons fall within the age group of 16 to 28 years. The skeletons of Grave nos. V and IX may be assigned an age of 30 to 35 years, and 28 to 34 years respectively (on an average, the skeletons measure about 1.80 m in height). Out of 14 skeletons exposed at the site, 9 are of males and 4 are of females. The sex of the child in Grave no. II has not yet been determined (Table 1).

Kennedy *et al.* (1986) have observed some pathological and anomalous features in some of the skeletons from Sarai Nahar Rai. Some of the osteological abnormalities include lipping of the thoracic and lumbar vertebrae (osteoarthritis), osteochondroma, and lipping on the patella. Squatting facets, hyper-development of attachments for the anaconeus and supinator muscles, rugose tendinous attachements to the palmar surfaces of manual phalanges, hypertrophy of tibial tuberosities, and perforation of the olecranon fossae of the humeri, are all markers of habitual stress.

Burials at Mahadaha

Twenty eight graves containing 32 skeletons were excavated at Mahadaha (Table 2). As indicated earlier, the graves located between the embankment and the canal were disturbed during the digging of the canal. The two partial skeletons recovered by canal workmen are not listed in Table 2. Stratigraphically, and on the basis of superimposition, the graves are ascribed to four different phases of the Mesolithic culture. Three graves belong to phase I, two to phase II, ten to phase III, and thirteen to phase IV (Table 2).

The graves, like those of Sarai Nahar Rai, were shallow and oblong, and except for two (Grave nos. I and V), were meant for single burials. The skeletons were either oriented

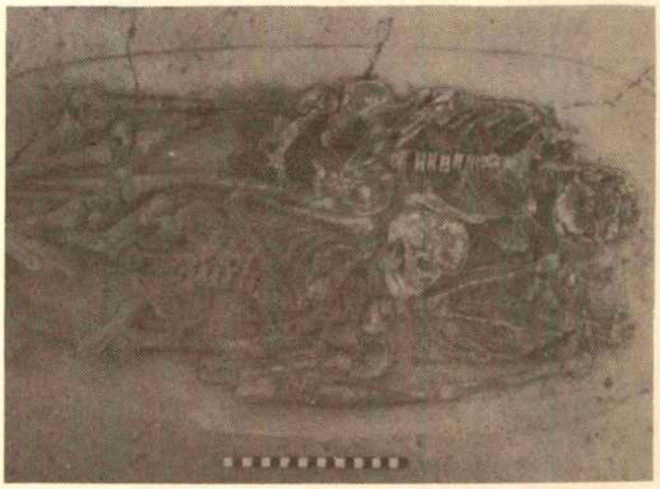

Fig. 8: Sarai Nahar Rai: Grave no. VII with four skeletons

Table 1: Human skeletons from Sarai Nahar Rai

Grave no.[1]	Sex	Age (in years)	Year of Excavation
I	Male	16-18	1972
II	—	Child	1972
III	Male	17-19	1972
IV	Male	25	1972
V	Female	30-35	1972
VI	Male	20-24	1973
VII[2]	Males(2)	17-24	1973
	Females(2)	17-24	1973
IX	Male	28-34	1972
X	Male	22-28	1972
XIII	Female	15-17	1972
—	Male	24-28	1970

1. All numbered graves excavated by the University of Allahabad. The burial without a grave number (—) was excavated by the Anthropological Survey of India, Calcutta
2. Multiple burial

west-east or east-west. In a few cases, however, there was no specific orientation.

All the burials, except for Grave no. XXIV (Fig. 9), were of the extended type and the dead were placed in a supine position, with the head tilted to the left or right. Although in a majority of the cases the hands were placed alongside the body, in one instance the left lower arm was placed on the chest and the right arm lay along the body. In another burial, one hand was placed on the abdomen and the other was alongside the body. One skeleton had both its hands on the chest. In the graves, the dead were generally placed on a 4 to 6 cm cushion of soil.

In the graves, burnt clay lumps and fragments of charred animal bones have been found which indicate that hearth material was also used for filling the graves. Some of the graves contain burial goods such as bone rings, bone arrowheads, microliths, rubbed ochre pieces and animal bones. Hardened white-ant houses have been wrongly identified as snails or coiled pottery.

The skeletons are generally well preserved, though the bones are in an advanced stage of fossilization and have acquired considerable weight. Although most of the skeletons have been disturbed, they provide vital information regarding burial rituals, age, sex, and palaeopathology.

The graves of phase I and phase II (all excavated in 1978) were oriented west-east. The skulls that were turned to the left were oriented westward. The hands were generally placed along the body, with the exception of the female skeleton in Grave I, which had both hands on the chest. Both phases yielded evidence of double burials, each with one male and one female. In phase I (Grave I), the deceased were placed side by side, the female lying on the left of the male, though in phase II (Grave V), the female was placed above the male (Fig. 10).

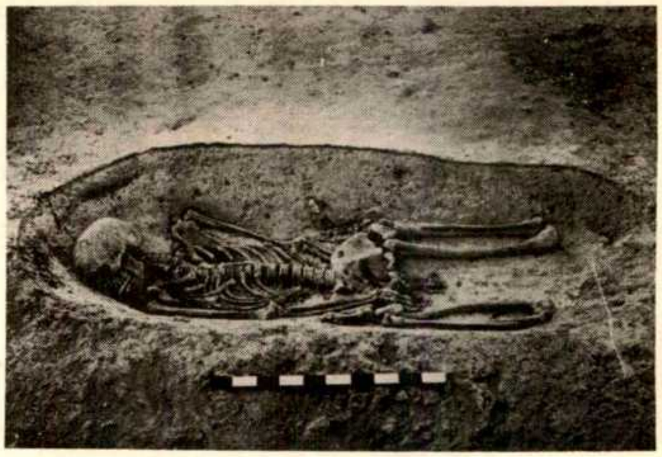

Fig. 9: Mahadaha: flexed burial, Grave XXIV

Of the ten burials in phase III (eight excavated in 1978 and two in 1979), eight were oriented west-east, one was oriented east- west, and the other south-east to north-west. In this phase, the hands were placed along the body, except in Grave XVIII, where the right hand was on the abdomen and the left along the body. Evidence showing the position of the skull was available only in three graves, where two of the skulls were turned to the left and one to the right.

The total number of excavated skeletons belonging to the last phase is 13 (two excavated in 1978, and 11 excavated in 1979). Of these, four skeletons (Grave nos. XVI, XVII, XX and XXVI) were oriented from east to west, seven were (Grave nos. XIII, XIV and XXI-XXV) west to east, and two were oriented (Grave nos. XXVII and XXVIII) south-east to north-west.

Five skeletons (Grave nos. XIII, XVII, XXII, XXV and XXVI) had both hands placed along the body. In Grave no. XXI, the left hand was folded upward and the right one

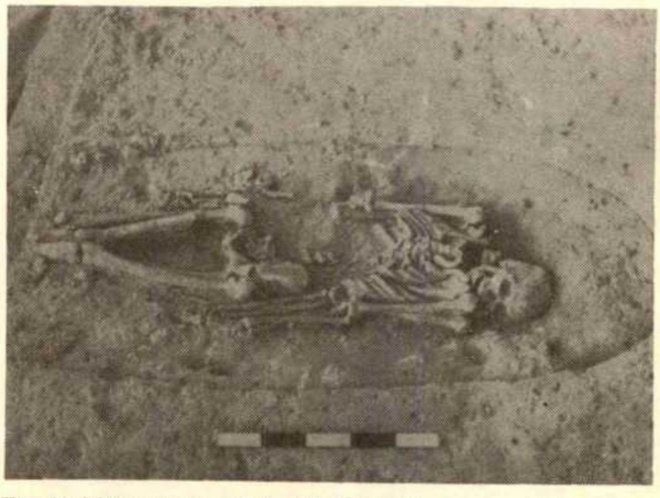

Fig. 10: Mahadaha: double burial, Grave V

Table 2: Human skeletons from Mahadaha[1]

Phase	Grave no.	Orientation	Sex	Age	Year of Excavation
I	I *	West-East	Male	Young Adult	1978
		West-East	Female	Young Adult	1978
	II	West-East	Male	Young Adult	1978
	III	West-East	Male	Adult	1978
II	IV	West-East	Male	Adult	1978
	V *	West-East	Female	Young Adult	1978
		West-East	Male	Young Adult	1978
III	IV	West-East	Male	Adult	1978
	VII	East-West	Female	Adult	1978
	VIII	West-East	—	—	1978
	IX	West-East	Female	Young Adult	1978
		West-East	—	—	1978
	XI	West-East	—	—	1978
	XII	West-East	Male	Adult	1978
	XV	West-East	—	Child	1978
	XVIII	West-East	—	Child	1979
	XIX	SE-NW	Female	Old Adult	1979
IV	XIII	SE-NW	Male	Young Adult	1978
	XIV	West-East	Male	18 years	1978
	XVI	East-West	Female	Adult	1979
	XVII	East-West	Female	Old Adult	1979
	XX	East-West	—	Young Adult	1979
	XXI	West-East	Male	Old Adult	1979
	XXII	West-East	Male	Middle-aged Adult	1979
	XXIII	West-East	Female	Adult	1979
	XXIV	West-East	Male	Adult	1979
	XXV	West-East	Female	Adult	1979
	XXVI	East-West	—	Child	1979
	XXVII	SE-NW	Male	Adult	1979
	XXVIII	SE-NW	Female	Old Adult	1979

1.Two partial skeletons found by canal workers are not included here

*Indicates a double burial

placed below the pelvis (Fig. 11). In Grave no. XXVIII, the right hand was placed diagonally on the abdomen and the left one along the body. In two graves, only the left hand was present and this was placed along the body.

Ten of these skeletons were female and 13 were male. For the rest, similar data are not available. Among these burials, only three were of children.

Detailed anthropological analyses of the human skeletal remains from Mahadaha were reported by Kennedy *et al.* (1992), and by Lukacs and Hemphill (1992). These provide valuable insights regarding the biological features of this population. A current summary of the dental anthropology of the Mahadaha and Sarai Nahar Rai specimens by Lukacs and Pal (1992) is presented in the succeeding article.

Burials at Damdama

Five seasons (1983 to 1987) of excavations at the site of Damdama have brought to light interesting evidence of human burial practices. The excavation in the western and central sectors revealed as many as 41 graves. The eastern sector did not yield burials, but their existence cannot be ruled out.

Forty one graves have been located and exposed at Damdama. Among these, Grave nos. VI (Fig. 3) XX, XVI, XXX (Fig. 4) and XXVI are double burials, while Grave no. XVIII is a multiple burial containing three individuals (Pal 1988). The rest of the burials are single burials, their orientation being west-east, with the head facing west. Graves I and XIX, however, belong to the last phase in which the skele-

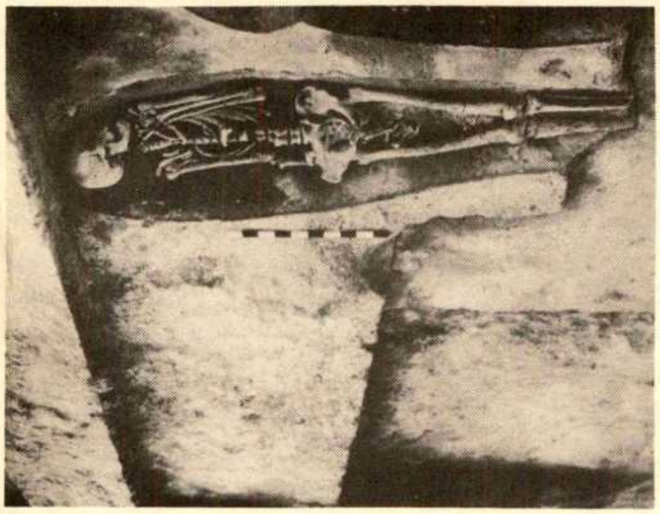

Fig. 11: Mahadaha: extended burial, Grave XXI

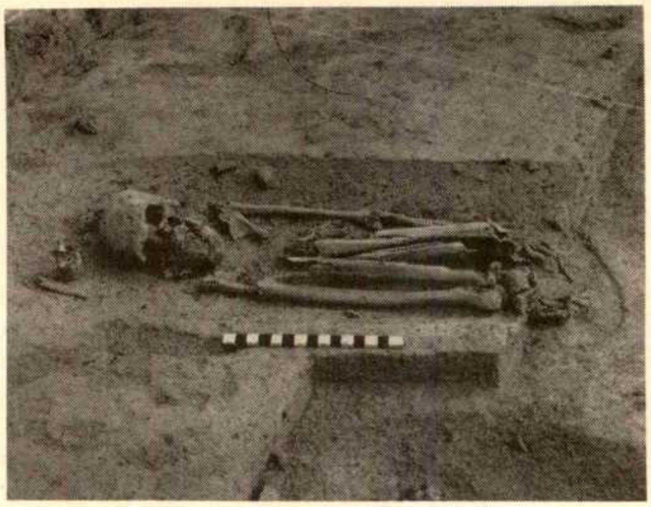

Fig. 13: Damdama: flexed burial, Grave I

tons were laid out in an east-west direction. The skeletons in each of the burials, except for two, have been placed in an extended position (Figs. 5 and 12). In Graves I (Fig. 13) and XXVIII (Figs. 6 and 14), the skeletons have been found in a flexed position. The position of the skeletons in Graves VIII and XI differ from the rest in that the skeleton in Grave XI (Fig. 15) has been placed in a prone position, while that in Grave VIII is in a lateral position. The other skeletons are in a supine position. The graves are shallow and oblong with tapering sides. It has been noticed that in most cases a hearth is situated next to a burial.

Some of the bones and microliths within the grave might have been incorporated in the soil that was used to cover the skeleton. However, the bone arrowheads found in Graves VII, XVI and XVIII can certainly be regard as grave goods. In Grave VII, two arrowheads and a perforated ivory pendant were found near the foot of the skeleton.

The central area of the site yielded five double burials and one multiple burial.

Conclusion

The dead were buried within the habitation area, generally in the vicinity of hearths. The graves may have been associated with fire as they contained refuse material from hearths. Fire was probably regarded as a life-giving source after a person had died.

Most of the bodies are placed in shallow oblong pits in the extended position. There are only three exceptions to this, one at Mahadaha, and two at Damdama where evidence of flexed burials has been found (Pal 1988). The individuals buried in a flexed position may have either been victims of punishment or they may have been sanyasis. Even today the corpses of sanyasis are immersed in rivers or buried in a sitting posture. The skeletons are generally found in a supine position, but in a few graves at Damdama, the skeletons were placed in a prone or lateral position. With a few exceptions, the skeletons are oriented west to east, or east to west, possibly signifying the positions of the sun and the moon.

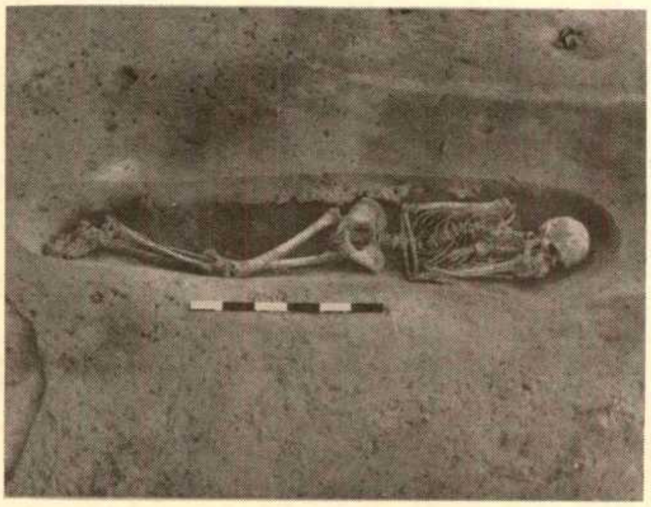

Fig. 12: Damdama: extended burial, Grave XXXVIII

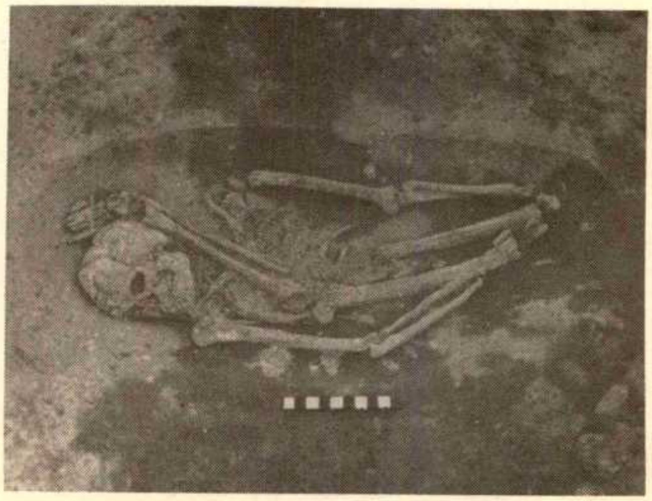

Fig. 14: Damdama: flexed burial, Grave XXVIII

Table 3: Human skeletons from Damdama

Phase	Grave no.	Orientation	Sex	Age	Year of Excavation
I	XII	West-East	Female	Adult	1985
II	XXXVIII	West-East	Male	Adult	1985
III	XVI[1]	West-East	Male	Adult	1985
		West-East	Male	Adult	1985
	XVII	East-West	Male	Adult	1985
	XL[2]	—	—	—	—
IV	XI	West-East	Male	Adult	1984
		West-East	Female	Young Adult	1986
V	XX[1]	West-East	Male	Adult	1986
	XXII	West-East	Male	Young Adult	1986
VI	X	West-East	Female	Adult	1984
	XV	West-East	Female	Adult	1985
	IX[3]	—	—	—	1984
VII	XIV	West-East	—	—	1985
	XXVIII	NW-SE	Male	Adult	1987
	II	West-East	Male	Adult	1983
	IV	West-East	—	—	1984
	V	West-East	Female	Adult	1984
	VI[1]	South-North	Female	Adult	1984
		North-South	Male	Adult	1984
	VII	West-East	Male	Young Adult	1984
	VIII	West-East	Male	Adult	1984
	XVIII[4]	West-East	Male	Young Adult	1984-85
		West-East	Male	Adult	1984-85
		West-East	Female	Adult	1984-85
VIII	XXX[1]	West-East	Female	Adult	1987
		West-East	Male	Young Adult	1987
	XXXII	SW-NE	Male	Young Adult	1987
	XXXIII	West-East	Male	Adult	1987
	XXXVI[1]	West-East	Female	Adult	1987
		West-East	Male	Young Adult	1987
	XXXVII	West-East	Female	Young Adult	1987
	XXXIX	NE-SW	Male	Adult	1987
	I	East-West	Female	Adult	1983
IX	III	West-East	Female	Adult	1984
	XIII	West-East	Female	Adult	1985
	XIX	East-West	Male	Adult	1986
	XXI	West-East	Female	—	1986
	XXIII	NE-SW	Female	Adult	1987
	XXIV	NE-SW	Male	Adult	1987
	XXV	NE-SW	Female	Adult	1987
	XXVI	NE-SW	Female	Young Adult	1987
	XXVII	SW-NE	Male	Adult	1987
	XXIX	SW-NE	Male	Adult	1987
	XXXI	West-East	—	—	1987
	XXXIV	SW-NE	Male	Adult	1987
	XXXV	West-East	—	Adult	1987
	XLI[2]	—	—	—	—

1. Double burial 2. Not excavated 3. Disturbed 4. Triple burial

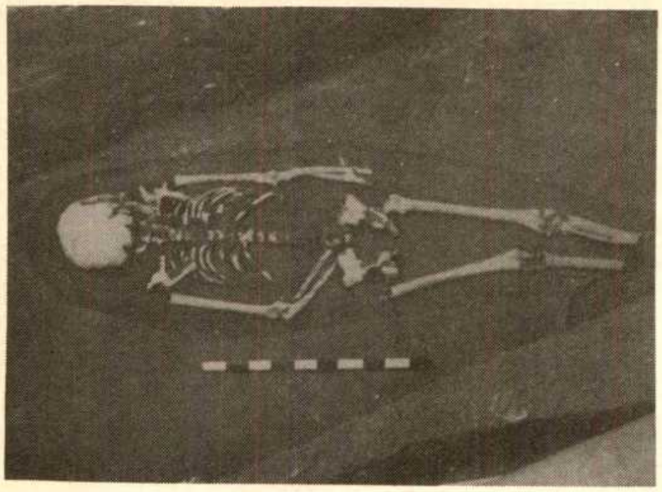

Fig. 15: Damdama: skeleton in prone position, Grave XI

The burials represent all age groups, particularly those of young individuals, thus suggesting that the life span of people during the Mesolithic was quite short. The multiple burials probably signify the development of strong family ties. However, it is difficult to explain the significance of the burial of three individuals, two males and one female, in a single grave (no. XVIII) at Damdama. On the whole, it seems that multiple burials were associated with individuals who occupied an important place in society. This is suggested by the presence of long, bone arrowheads in the burials at Damdama, and by the discovery of a bone necklace and earring at Mahadaha.

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Dental Anthropology of Mesolithic Hunter-Gatherers: A Preliminary Report On The Mahadaha And Sarai Nahar Rai Dentition

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Abstract

Careful analysis of human dentition often yields important clues regarding the biological attributes of prehistoric populations. Yet, while inferences regarding diet, subsistence, occupational activities, health and biological interrelationships are pertinent to archaeological research, the role of dental anthropology has too often been neglected.

This preliminary report summarizes previous anthropological research on the Mesolithic hunter-gatherers of the Ganga Plains, and presents conclusions derived from the analysis of the Mahadaha and Sarai Nahar Rai dental remains. Observations on dental attrition, ten pathological lesions of the teeth and jaws, two measurements of the dental crown and twenty-six anatomical features of the tooth crowns were included in the study.

These skeletal series are characterized by heavy dental attrition, low rates for dental abscesses and caries, moderately high enamel hypoplasia, large tooth size and primitive, but not morphologically complex teeth. Overall, the dentition of Mesolithic populations of the Ganga Plains suggests the presence of heavy dietary and occupational stresses, and indicates a pathology pattern consistent with a hunting-foraging subsistence system and primitive food preparation technology. The absence of many similarities in dental morphology between these Mesolithic skeletal series and other South Asian prehistoric groups suggests that these early inhabitants of the Ganga Plain may not have made a substantial biological contribution to later populations of peninsular India.

Introduction

Questions of paramount anthropological importance often remain unanswered or elusive due to the absence or inadequacy of relevant data. Until recently, questions regarding specific aspects of the biocultural history of the Indian subcontinent could not be entertained, despite their broad anthropological significance. For example, 1) what is the relationship between the mode of subsistence (hunting and gathering vs. agriculturalism) and the patterns of dental and general health among prehistoric populations? 2) how did the stresses associated with a Mesolithic technology and lifestyle affect the skeleton and dentition of early human populations? 3) is there close correspondence between the archaeologically based culture history and the biologically based population history of the Subcontinent? and 4) has human occupancy of the Ganga River Valley been characterized by a single continuously evolving group of human populations, or discontinuously, by repeated replacements of one human population by another. Recently completed research, and work currently in progress, permits tentative answers to some of these questions and optimism that preliminary answers to others will soon be forthcoming. The goal of this report is to provide: 1) a brief history of anthropological research on human remains from the Mesolithic Lake Cultures of the Ganga Plain, and 2) a summary of research conclusions based upon analysis of human skeletal and dental remains from Mahadaha and Sarai Nahar Rai. The results reported below must remain tentative until comprehensive osteological and dental research currently in progress on Mesolithic human remains from Damdama and Lekhahia is completed.

Previous Research

The history of discovery of human skeletal remains with Mesolithic cultural associations in the Indian subcontinent has been reviewed by Kennedy (1980) and Kennedy *et al.*

(1986), and need not be recounted here. News of archaeological artefacts and human skeletal remains derived from Sarai Nahar Rai, the first Ganga Plains Lake Culture site discovered, was reported by Sharma (1973) to an international audience of prehistorians in 1973. The nearby sites of Mahadaha, excavated in two seasons (1977-78 and 1978-79), and Damdama, excavated between 1983 and 1987, have both yielded abundant human skeletal remains (Pal 1985; Sharma *et al.* 1980; Pal 1988; Varma *et al.* 1985). The location of these sites is provided in Fig. 1. Collectively, these human osteological discoveries have tremendous anthropological significance, since they promise to reveal in some detail the biological characteristics of the Mesolithic inhabitants of the Ganga Plain, and to provide preliminary answers to the research questions outlined above. For these reasons, a brief review of anthropological research on human remains from these Ganga Plain sites is provided below as a useful context for the results and conclusions reported here.

Discovered in 1968, Sarai Nahar Rai is located about 38 km north of the city of Allahabad, in Pratapgarh District, Uttar Pradesh, and has yielded fourteen human skeletons. The first anthropological reports on the human remains from Sarai Nahar Rai were made by P.C. Dutta and his associates, officers of the Anthropological Survey of India, Calcutta. These early publications on Late Stone Age man in India focused on a single specimen from Sarai Nahar Rai (SNR-4[1]) excavated in 1970. While the results of Dutta's analysis of the SNR-4 specimen were initially reported, together with a photograph of the cranium in Norma Frontalis, in the prestigious journal Nature, subsequent research findings were published in Indian scientific journals and did not receive wide international attention (Dutta 1971; Dutta 1973; Dutta and Pal 1972; Dutta *et al.* 1972). In January 1975, Lukacs conducted a preliminary examination of the dentition of the Sarai Nahar Rai and Lekhahia skeletal series. The results of this study were appended to his doctoral dissertation concerning dental variability among living peoples of North India (Lukacs 1977). In 1980 Kennedy examined the human bones from Mahadaha and Sarai Nahar Rai during a research visit to Allahabad University. The results of his investigations were published in the form of a comparative summary of the Sarai Nahar Rai and Mahadaha skeletal series (Kennedy 1984), and as monographic reports on the Sarai Nahar Rai (Kennedy *et al.* 1986) and the Mahadaha (Kennedy *et al.* 1992) human skeletal series. In February 1988, Lukacs and his research assistant Brian E. Hemphill re-studied the Sarai Nahar Rai dental remains, and conducted a multi-faceted study of the dentition of the Mahadaha skeletons. The results of this investigation appear in Lukacs and Hemphill (1992), Pastor and Johnston (1992) and in Lukacs (1990), and are summarized below. It was during the course of research on the Mahadaha dentition in 1988, that the availability of 46 human skeletons from Damdama, another Mesolithic Lake Culture site, became known to Lukacs and plans for the current 1991-92 research project were initiated.

A Synopsis of the Results

The analysis of human dental remains, in either prehistoric archaeological or in forensic anthropological contexts, is a complex and multi-faceted task. This summary report of salient research findings is divided into the four primary areas of inquiry in dental anthropology: 1) dental attrition or tooth wear, 2) dental pathology, 3) dental morphology, and 4) odontometry or dental metrics. The findings reported here are based on sixteen Mahadaha specimens and five Sarai Nahar Rai specimens that preserve dental remains. This study sample is clearly a subset of the total skeletal sample recovered from these sites (Pal 1992, Tables 1 and 2), and may possibly bias the conclusions reported below. Unless otherwise stated, the results reported below pertain primarily to the Mahadaha osteological series, though the Sarai Nahar Rai skeletons generally exhibit the same phenotypic characteristics.

Dental Attrition

The severity and pattern of dental wear in human populations yield insights into both the consistency of the diet and possibly non-dietary or occupational uses of the teeth (eg. teeth as tool or vice-grip, in manufacturing activities). The degree of dental wear at Mahadaha was categorized into three classes of progressively increasing severity: 1) enamel polish only 2) exposure of dentine and 3) exposure of secondary, or reparative, dentine. Only one specimen (MDH-1[1]) exhibited enamel polish, while dentine exposures of varying size were observed in five individuals, or 33.3% of the sample. Secondary, or reparative, dentine exposures were present in nine specimens (60%), indicating that severe levels of attrition are common among the people of Mahadaha. Exposure of the pulp chamber of the tooth was observed in 21.4% of the sixteen Mahadaha specimens. A noteworthy finding is that the etiology of pulpal exposure at Mahadaha is severe attrition of the occlusal surface, not dental caries. Another indicator of the severity of masticatory pressures is the presence of 'dislocated' teeth in the Mahadaha skeletal series. Tooth dislocation refers to the continued functional use of a tooth after the crown is worn away, and the erupted, lingually-tilted roots serve as the occlusal surface (Clarke and Hirsch 1991). This phenomenon is commonly observed among the Australian Aboriginals, a population noted for high masticatory stress in association with primitive food processing technology (Brown 1992; Danenberg *et al.* 1991). The prevalence of severe dental wear, coupled with attrition-induced pulp exposure

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[1] Specimen numbers begining with MDH or SNR followed by an Arabic number refer to individual skeletons (MDH-27) and comprise the anthropological unit of study, while graves, which are archaeological features, are designated by site name and Roman numerals (Damdama grave XVIII).

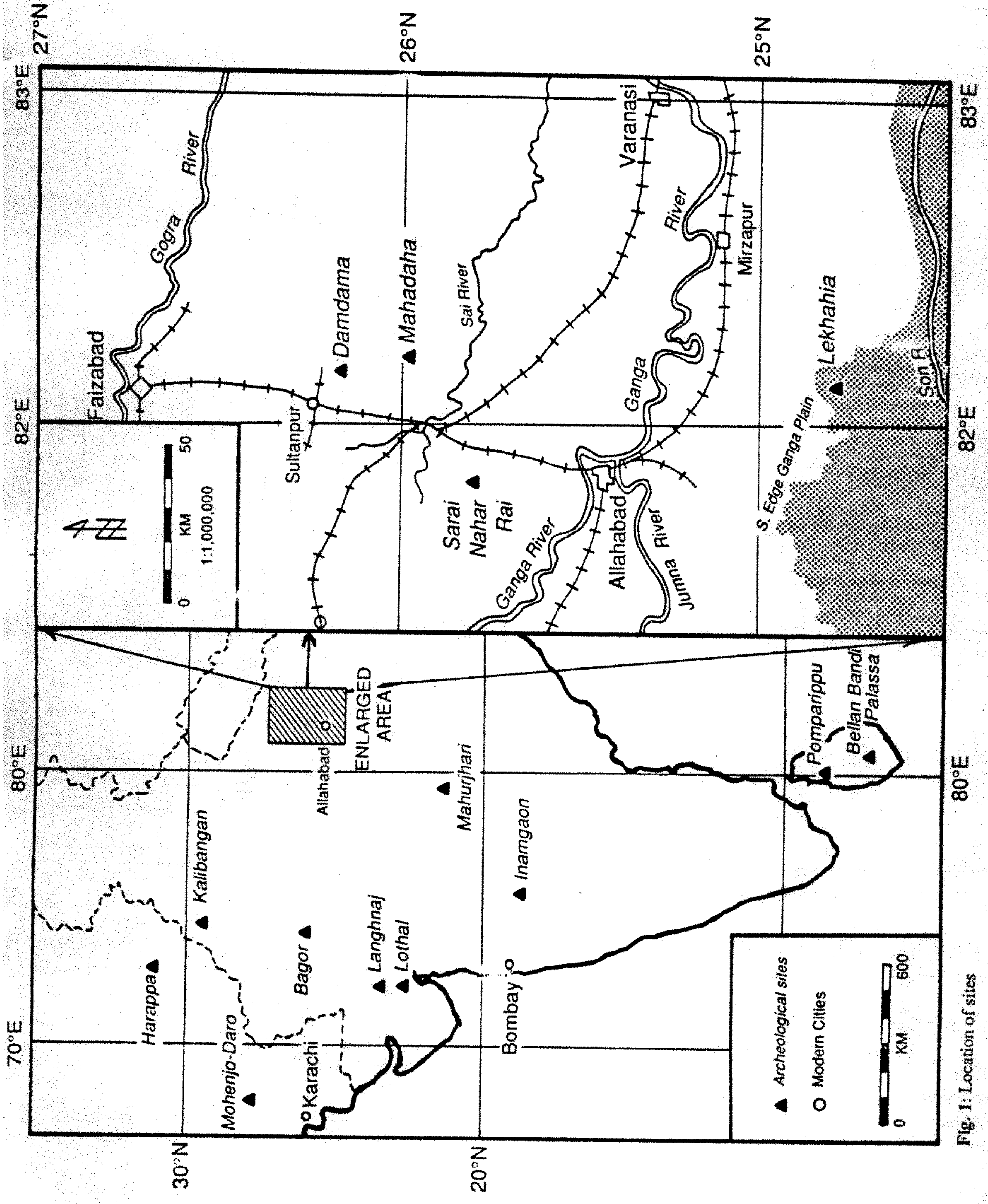

Fig. 1: Location of sites

and dislocation of molar teeth, suggests that the people of Mahadaha consumed an abrasive diet.

Another striking dental wear feature found in the Mahadaha skeletal series is the interproximal groove — a notch worn into the cervix of the tooth at, or near, the cemento-enamel junction. The presence of interproximal grooves in South Asian prehistoric skeletons were first reported from Neolithic and Chalcolithic Mehrgarh and from

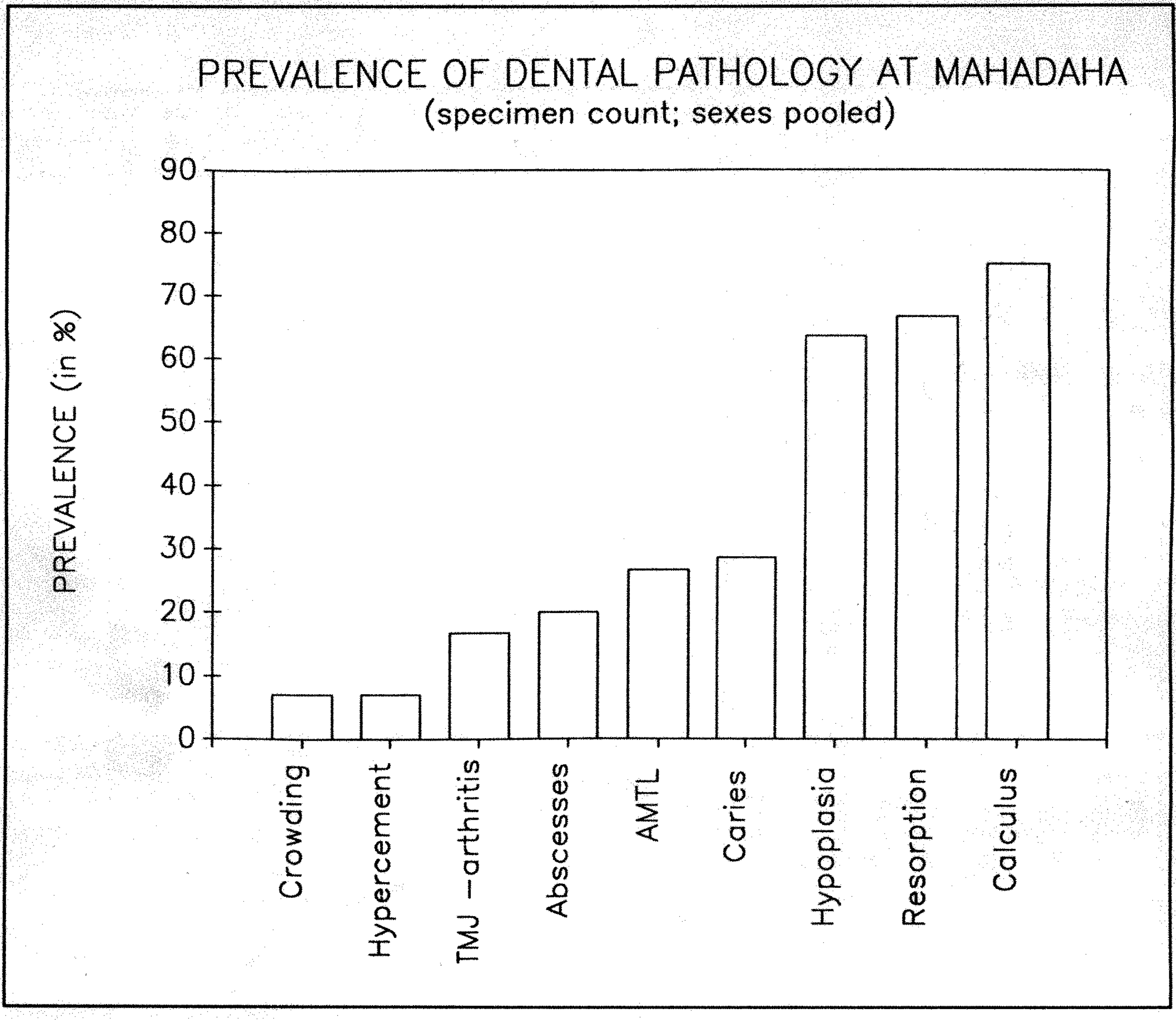

Fig. 2: Prevalence of dental pathology at Mahadaha

Table 1: Prevalence of dental afflictions at Mahadaha[1]

	MALE				FEMALE			TOTAL		
Dental Affliction	**+**	**(n)**	**%**		**+**	**(n)**	**%**	**+**	**(n)**	**%**
Crowding	1	(10)	10.0	ns	0	(4)	0.0	1	(14)	7.1
Hypercementosis	0	(10)	0.0	ns	1	(4)	25.0	1	(14)	7.1
TMJ arthritis	0	(10)	0.0	*	2	(4)	50.0	2	(12)	16.7
Abscesses	1	(10)	10.0	ns	2	(5)	40.0	3	(15)	20.0
Ante-mortem tooth loss	1	(10)	10.0	*	3	(5)	60.0	4	(15)	26.7
Caries	3	(10)	30.0	ns	1	(4)	25.0	4	(14)	28.6
Hypoplasia	6	(9)	66.7	ns	1	(2)	50.0	7	(11)	63.6
Alveolar resorption	5	(10)	50.0	*	5	(5)	100.0	10	(15)	66.7
Calculus	7	(9)	77.8	ns	2	(3)	66.7	9	(12)	75.0

[1] in order of increasing prevalence;

ns = non-significant difference; * = significant at a = 0.05

Harappa, Pakistan (Lukacs and Pastor 1988). Usually found between adjacent teeth in the dental arcade, interproximal grooves are generally attributed to non-dietary occupational activities such as preparing sinew for bowstrings or hafting points, or habitual tooth-picking with a bone needle. Other explanations have been proposed for the origin of interproximal grooves including probing or treating dental caries or crowded teeth (Milner and Larsen 1991; Lukacs and Pastor 1988). Two females from Mahadaha (MDH-30) exhibit interproximal grooves in their maxillary molar teeth. The fact that neither of these wear features is associated with dental pathology (crowding or caries) suggests that they are best classified as originating from habitual or compulsive tooth-picking, rather than from therapeutic or occupational activities (Formicola 1988).

Dental Pathology

The type and frequency of dental diseases in a population provide important clues regarding its health status, dietary patterns and subsistence strategy. Hunters and gatherers for example, have a rather different suite of dental diseases than sedentary populations that rely primarily upon processed foods derived from agricultural activities (Cohen and Armelagos 1984; Lukacs 1990, 1992a). The pattern of dental disease in prehistoric human skeletal collections provides vital information for both archaeologists and anthropologists. Dental afflictions regarded as pathological in this analysis included abscesses, alveolar resorption (periodonta disease), ante-mortem tooth loss, calculus, caries, crowding, enamel hypoplasia, hypercementosis, and temporomandibular (TMJ) joint degeneration. The presence and severity of each type of disease lesion was recorded according to the guidelines described by Lukacs (1989). The prevalence of dental pathology at Mahadaha is based upon the number of individuals affected by a lesion, divided by the number of specimens in which the relevant condition could be observed (individual count method). Due to variation in the preservation of skeletal and dental parts from specimen to specimen, sample size will vary from one dental disease to another. The prevalence of dental afflictions at Mahadaha is presented in Table 1 and Fig. 2. Dental conditions that are rare at Mahadaha include hypercementosis and dental crowing. Abscesses, ante-mortem tooth loss, caries and TMJ disease occur in low frequency. Dental lesions present in high incidence include alveolar resorption, calculus and gross enamel hypoplasia.

Four dental afflicitions, abscesses, ante-mortem tooth loss, caries and pulp exposure, were also examined by tooth type (incisor, canine, premolar, molar), and by percentage of teeth afflicted by each disease (tooth count method). The results are presented in Table 2. The total tooth count prevalence of these dental diseases (Table 2, bottom line), in order of increasing frequency, is: caries (1.15%), abscesses (3.45%), pulp exposure (7.28%), and ante-mortem tooth loss (11.82%). Analysis by tooth type reveals that dental abscesses and pulp exposure are rather evenly distributed throughout the four tooth classes, suggesting that the biomechanical stresses of mastication were roughly uniform throughout the dental arcade. At Mahadaha, most teeth with dental abscesses also displayed evidence of pulp exposure, indicating an association between these two dental afflictions.

Only three dental caries were observed in the Mahadaha skeletal series. All are located in molar teeth and other tooth classes are unaffected by this lesion. The caries prevalence for molar teeth is 2.97% (n=101). Caries lesions were never severe enough to penetreate the pulp chamber of the tooth, suggesting that ante-mortem tooth loss in the Mesolithic Lake Culture people was not due to carious destruction of the tooth.

Odontometry

Though certainly less conspicuous than variation in human skin colour, differences in tooth size, between individuals and populations, is an important aspect of human biological variation (Lukacs 1992b). As part of the oral cavity, teeth serve as man's primary food processing device. On a worldwide basis tooth size varies inversely with level of techno-cultural development, and populations with hunting-gathering subsistence strategies generally have larger teeth than groups whose food is derived from agricultural pursuits (Brace *et al.* 1987; Brace and Montagu 1977). For these reasons documenting the dimensional characteristics of the dentition of prehistoric populations is an important part of a thorough study of human skeletal remains.

The size of a tooth is conventionally assessed by measuring its maximum length (mesiodistal) diameter — MD) and its maximum breadth (buccolingual diameter — BL). Measurements were made by Lukacs with a Helios needle-point dial caliper and were rounded to the nearest 0.05 mm.

A paired-samples test for departures from bilateral symmetry between measurements of the right and left side revealed only two significant differences (M^3-BL and M_3-MD). Consequently mean MD and BL crown diameters for the left side are presented, together with statistical data in Table 3. The 'robustness' of a tooth, or the approximate size of the dental crown biting surface, is estimated by multiplying the MD and BL diameters. The crown areas for teeth from Mahadaha are presented in Table 4. This value, sometimes called the cross- sectional crown area, when summed for all teeth on one side of the jaw, yields an approximate indication of overall tooth size (in mm^2; Brace 1980). The summed cross-sectional crown area for the Mahadaha dentition is 1314 mm^2, indicating teeth of overall large size. Surprisingly, two commonly used indices of tooth size, Van Reenan's 'Tooth Material Index' and Flower's

Table 2: Prevalence of selected dental afflictions by tooth class

	Dental Affliction											
										Ante-Mortem		
Tooth Class	**Abscesses**			**Caries**			**Pulp Exoisyre**			**Tooth Loss**		
	+	(n)	%	+	(n)	%	+	(n)	%	+	(n)	%
Incisor	2	(51)	3.92	0	(51)	0.00	2	(51)	3.92	12	(63)	19.00
Canine	2	(35)	5.71	0	(35)	0.00	5	(35)	14.30	0	(35)	0.00
Premolar	2	(74)	2.70	0	(74)	0.00	5	(74)	6.36	9	(83)	10.80
Molar	3	(101)	2.97	3	(101)	2.97	7	(101)	6.93	14	(115)	12.20
TOTAL	9	(261)	3.45	3	(261)	1.15	19	(261)	7.28	35	(296)	11.82

Dental Index', both classify the Mahadaha dentition as microdont, or small toothed. This finding stands in dramatic contrast to the 1314 mm² value for cross-sectional area, which clearly indicates a large-sized dentition. This contradiction is explained by the fact that both Van Reenan's and Flower's Indices rely primarily upon MD diameters of the premolar and molar teeth. The Mahadaha dentition , however, exhibits large crown diameters in incisor and canine teeth, and in the BL diameter of premolar and molar teeth, and none of these dimensions are reflected in either of these dental indices.

Dental Morphology

Anatomical or morphological features of the crown and roots of teeth are determined to a considerable extent by genetic factors (Brown 1992; Townsend 1992). Populations that share many similarities in dental morphology are therefore assumed to tbe closely related to one another genetically. When two populations display many differences in the frequency of dental morphological attributes, anthropologists can safely assume that a close genetic relationship does not exist between them. By careful documentation of interpopulation relationships through space and time, the anthropologist seeks to determine the biological history of a geographical region. A thorough knowledge of the dental morphology of the Ganga Lake Culture people will ultimately reveal their role in the population history of the Indian subcontinent.

Morphological traits routinely observed on permanent dental remains were included in the analysis of the Mahadaha and Sarai Nahar Rai dentition. Twenty six variables were recorded including features similar to the widely known shovel-shaped upper incisor, and cusp number and groove pattern of lower molar teeth. A complete listing of the traits observed, and references to the origional citations describing them, can be found in Turner *et al.* (1991) and in Lukacs and Hemphill (1992). The dental morphology of the Mahadaha skeletal series can be characterized as follows.

a) Maxillary anterior teeth are lightly, but consistently sculpted. That is, they possess high levels of lingual and labial shovelling, low prevalences for tuberculum dentale, labial curvature, and interruption grooves. These teeth are not morphologically complex.

b) Although ancillary cusps such as Carabelli's trait and the parastyle are generally absent from this series, maxillary molars are fairly robust with well developed hypocones.

c) Mandibular anterior teeth are lightly sculpted, but exhibit slight yet consistent lingual shovelling.

d) Mandibular premolar teeth exhibit two lingual cusps in low frequency (P_3=14.3%, P_4=28.4%).

e) Mandibular molar teeth are morphologically conservative; five cusps and the Y groove pattern are commonly present. Accessory cusps, including the entoconulid, metaconulid and protostylid are extremely rare.

Comparative Analysis and Discussion

Dental Attrition

Wear on the occlusal or biting surfaces of teeth is heavy and suggests a combination of hunting and gathering subsistence together with a coarse and abrasive diet. In fact, rapid wear of the teeth is the primary cause of tooth loss during life among these Mesolithic Lake Culture people. The presence of interproximal grooves reflects habitual or compulsive tooth-picking, rather than occupational, palliative or therapeutic activities.

Dental Pathology

The types and prevalences of dental disease strongly suggest a subsistence pattern that depended heavily upon hunting and gathering. The low dental caries prevalence (1.2% tooth count) is the single most important indicator of the dietary

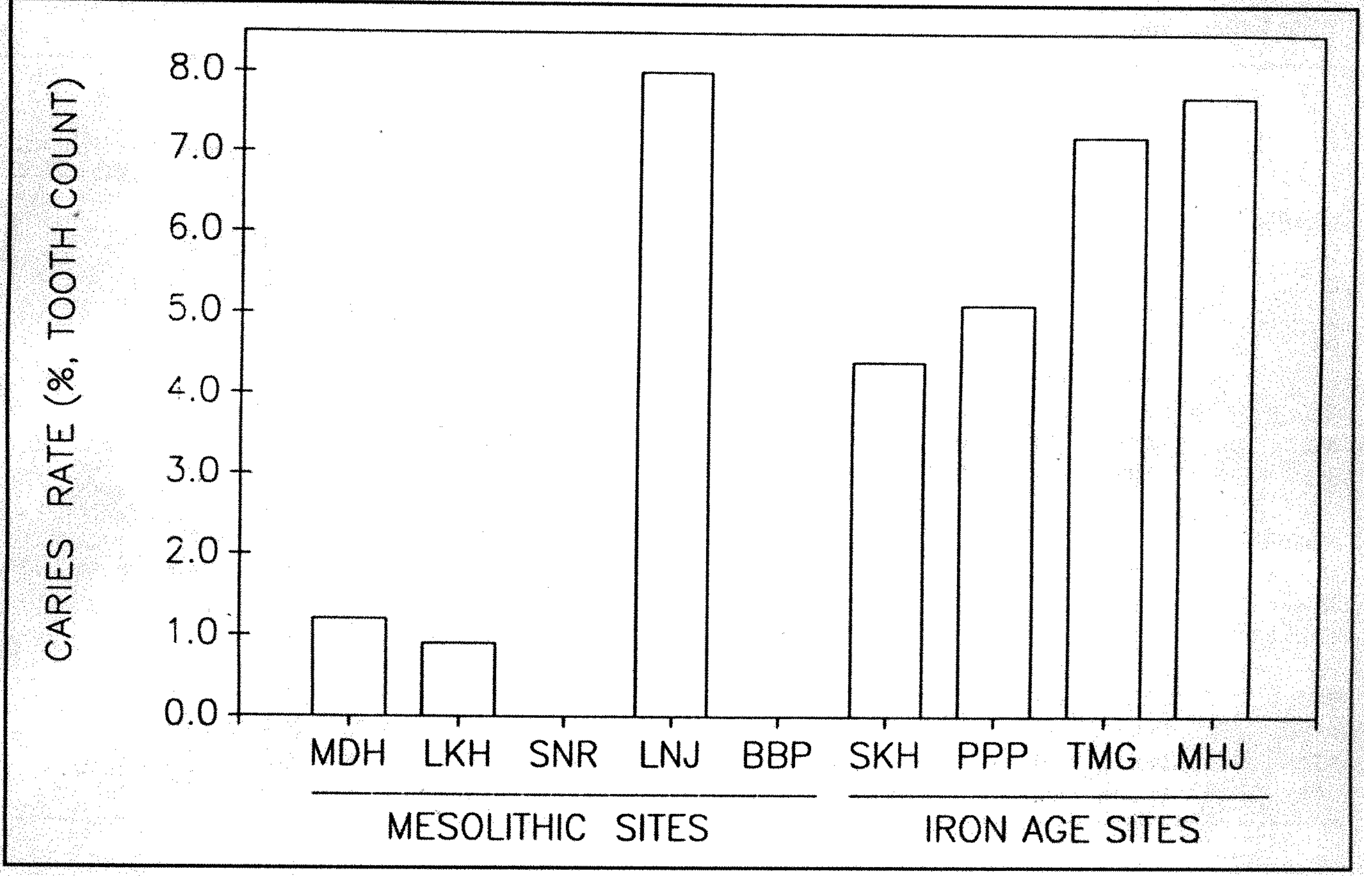

Fig. 3: Caries prevalence among Mesolithic and Iron Age South Asians

pattern , and implies that the Mahadaha diet, like that of most hunter-gatherers, was low in carbohydrates, refined sugars and soft sticky foods (Fig. 3). Skeletal series with Iron Age cultural associations (SKH-Sarai Khola, PPP-Pomparippu, TMG-Timargarha, MHJ-Mahurjhari) have caries rates between 4.0% and 8.0%, while most Mesolithic sites exhibit caries prevalences of less than 1.5% (MDH-Mahadaha, LKH-Lekhahia, SNR-Sarai Nahar Rai, BBP-Belan Bandi Palassa). The exceptionally high caries prevalence for Langhnaj (LNJ) in comparison with other Mesolithic skeletal series may be explained by exchange with settled agriculturalists (Lukacs 1990; Lukacs and Hemphill 1992). The moderate incidence of pulp exposure is primarily caused by dental wear, not dental caries. This observation, and occasionally heavy wear of anterior teeth, suggests that teeth may have often served dual functions: masticating coarse foods subject to little preparation, and gripping non-food items in the process of manufacturing tools and sinew. The high frequency of mild forms of enamel hypoplasia suggests that growth disruptions, due to illness or to periods of malnutrition, were common and chronic. The mild nature of the hypoplastic defects implies that the stresses of disease and malnutrition affecting the Lake Culture people were successfully met by biological responses, allowing for long-term adaptation and prosperity.

Tooth Size

Tooth size among the people of Mahadaha is large. Although it cannot be characterized as megadont by either Flower's or Van Reenan's Dental Indices, the summed cross-sectional crown area of 1314 mm^2 for Mahadaha is the largest yet reported for the Indian subcontinent. An important factor contributing to the large size of the Mahadaha dentition is the lack of reduction of distal members of a tooth group. For example, lower first, second and third molar teeth are approximately equal in size, rather than displaying progressive diminution from M1 to M3 as in living humans. In size, the Mahadaha dentition is very similar to the Mesolithic human skeletons from Zhou Gou Dian, China which have summed cross-sectional area of 1305 mm2 (Brace *et al.* 1984). Other skeletal series with approximately similar sized teeth include a sample from Neolithic Mehrgarh (1257 mm^2, Lukacs *et al.* 1985) and Bellan Bandi Palassa (1255 mm^2, Kennedy 1965). These associations of large tooth size with Mesolithic and Neolithic cultural technologies strongly suggest a causal linkage between cultural development and human biological evolution.

Dental Morphology and Genetic Relations

The morphological features of the Mahadaha and Sarai

Table 3: Mean crown diameters of permanent teeth from Mahadaha (left side; in mm)

	Mesiodistal					**Buccolingual**				
	x	**(n)**	**sd**	**min**	**max**	**x**	**(n)**	**sd**	**min**	**max**
Maxilla										
I1	8.80	(3)	0.35	8.4	9.0	7.70	(4)	0.35	7.4	8.0
I2	7.17	(4)	0.22	6.9	7.4	6.80	(5)	0.54	6.2	7.5
C	8.20	(5)	0.50	7.4	8.8	9.28	(6)	0.41	8.6	9.7
P3	7.13	(7)	0.48	6.2	7.7	9.99	(8)	0.54	8.9	10.7
P4	6.60	(6)	0.40	5.8	6.9	10.05	(6)	0.45	9.4	10.6
M1	10.24	(7)	0.68	9.2	11.2	12.21	(8)	0.43	11.4	12.9
M2	9.76	(8)	0.76	8.8	10.7	12.12	(8)	0.62	11.0	12.9
M3	8.93	(7)	0.42	8.4	9.5	11.51	(7)	1.08	10.3	13.5
Mandible										
I1	5.58	(5)	0.26	5.3	5.9	6.40	(6)	0.22	6.2	6.6
I2	5.92	(4)	0.43	5.5	6.5	6.68	(5)	0.19	6.4	6.9
C	7.42	(6)	0.38	7.0	8.0	8.39	(7)	0.78	6.9	9.4
P3	7.40	(7)	0.40	7.0	8.1	8.79	(8)	0.37	8.3	9.3
P4	7.24	(7)	0.79	6.2	8.7	9.24	(8)	0.49	8.5	9.8
M1	11.47	(7)	0.80	10.2	12.5	11.54	(7)	0.52	10.6	12.1
M2	11.41	(7)	0.37	10.9	12.0	11.16	(7)	0.28	10.6	11.4
M3	11.02	(5)	0.66	10.0	11.6	11.08	(5)	0.54	10.6	11.9

Nahar Rai dentitions were compared with four other prehistoric South Asian skeletal series, including: 1) Neolithic Mehrgarh (MR 3, 6500 BC, Lukacs 1988), 2) Chalcolithic Inamgaon (INM, 1600-700 BC, Lukacs 1987), 3) Sarai Khola (SKH, 1000 BC, Lukacs 1983), and 4) Timargarha (TMG, 1500-500 BC, Lukacs 1983). The dental morphology of all skeletal series were initially studied by Lukacs, avoiding any error due to inter-observer variability. Three significant results were derived from a comparative analysis of dental morphology based on the Mean Measure of Divergence statistic. First, the Mesolithic inhabitants of the Ganga Plain have closer affinities to the Neolithic series from Mehrgarh (MR 3), than to the geographically more proximate, but temporally more distant, late Chalcolithic series from Inamgaon. This finding suggests that the people of the western Deccan Plateau (Inamgaon) may have been influenced biologically (and genetically) to a greater extent by the people of the Indus Valley than by people of the Ganga Plain.

Secondly, the people of Inamgaon are clearly more similar to the Neolithic inhabitants of Mehrgarh in their dental morphology, than they are to the late Bronze — early Iron Age people of Timargarha. This result could be interpreted to suggest that there may have been a movement of people from the Indus Valley drainage into the Deccan Plateau of peninsular India after the Neolithic (MR 3), but prior to the Chalcolithic (MR 2) in Baluchistan. Third, the Mesolithic Lake Culture people of the Ganga Plain appear most different in dental morphology from the people of Sarai Khola and Timargarha, sites located in northwestern Pakistan. In fact, these early inhabitants of the Ganga Plains may have made little direct biological contribution to the people now widely distributed over the Indian subcontinent. These findings must remain tentative for the moment, as they are based upon small sample sizes. Re-analysis of prehistoric population relationships following the completion of research on the Damdama skeletal series is essential if these findings are to be confirmed.

Conclusions

This study of the dental characteristics of the Mahadaha and Sarai Nahar Rai skeletal series adds substantially to existing knowledge of diet and subsistence, tooth size and technology, and biological interrelationships among Mesolithic people of the Gangetic Plain of North India. The conclusions derived from this study are succinctly enumerated below.

1) Teeth were subjected to heavy occlusal wear implicating primitive food preparation technology and a coarse diet. Excessive anterior dental wear in specific specimens implies use of incisors and canines as a manipulative device in occupational activities. Interproximal wear grooves are probably due to habitual tooth- picking with a bone needle.

2) The types and prevalences of dental disease strongly suggest a hunting and gathering lifestyle. The low

Table 4: Mean crown areas for permanent teeth from Mesolithic Mahadaha (in mm^2)

	Left						Right					
	x	n	sd	min	max	cv	x	n	sd	min	max	cv
Tooth												
Maxilla												
I1	66.9	3	4.93	62.2	72.0	7.73	67.7	3	1.09	66.4	68.5	1.61
I2	47.5	4	3.34	44.0	51.8	7.03	46.1	2	1.86	44.7	47.4	4.04
C	75.7	5	7.20	63.6	81.0	9.51	70.3	4	10.66	59.2	81.8	15.16
P3	71.0	7	7.88	60.8	82.4	11.10	69.0	4	8.69	61.6	81.3	12.60
P4	65.7	5	6.00	56.3	71.0	9.14	62.2	4	3.40	57.7	65.7	5.46
M1	124.3	7	11.18	104.9	140.0	8.99	123.5	4	10.34	109.3	133.8	8.37
M2	118.6	8	13.33	96.8	131.6	11.15	115.4	5	15.86	97.7	134.4	13.74
M3	103.1	7	14.09	87.4	128.3	13.67	105.3	4	12.33	91.4	121.0	11.70
Mandible												
I1	35.5	5	2.29	32.7	38.9	6.45	37.1	5	3.64	32.9	40.8	9.82
I2	39.2	4	2.58	36.9	42.9	6.59	38.6	4	3.22	35.1	42.9	8.33
C	61.0	6	6.87	48.3	67.6	11.26	57.9	5	8.71	48.9	67.6	15.05
P3	64.8	7	5.67	58.1	71.3	8.76	62.3	5	3.66	59.8	68.5	5.88
P4	66.7	7	10.08	56.1	84.4	15.11	64.0	5	4.96	58.2	69.6	7.76
M1	132.7	7	14.34	108.1	151.3	10.80	133.9	5	15.66	110.1	148.8	11.70
M2	127.4	7	6.24	119.8	136.8	4.90	127.4	7	8.26	114.5	137.8	6.48
M3	122.1	5	9.77	112.0	135.7	8.00	124.6	6	9.55	111.3	136.9	7.67
Sum Max	672.8						659.5					
Sum Mand	649.4						645.8					
ToT Sum	1322.2						1305.3					

caries rate in particular is due to the combined effects of a significant proportion of meat in the diet and the coarsely textured nature of the produce consumed. Rapid dental wear due to coarse food erases cusps and fissures from the teeth, denying food particles suitable locations for entrapment and caries formation.

Ante-mortem tooth loss is due to attrition-induced pulpal exposure, not to dental caries. This finding also suggests a hunting and collecting subsistence strategy, independently of the archaeological record.

3) Tooth size is large. Despite the failure of specific dental indices to indicate this, the cross-sectional crown area of 1314 mm^2 reflects the large size of both anterior and posterior teeth. Large teeth are biologically and evolutionarily adaptive given the tough diet and manipulative stresses to which they were subjected. A large tooth wears more slowly and has a more prolonged functional life than a small tooth.

4) Genetically, the Mesolithic Lake Culture people of the Ganga Plain are not closely related to any of the four prehistoric skeletal series to which they can be compared. While they bear some resemblance dentally to the Neolithic inhabitants of Mehrgarh, Pakistan, the Mesolithic people of the Ganga drainage can only be regarded as having a distant relationship with them. It appears that the people of Sarai Nahar Rai and Mahadaha may have contributed little biologically to later populations of the Deccan Plateau.

5) Future research must enhance the sample size upon which these conclusions are based if their validity is to be confirmed, fill spatial and temporal gaps in the human skeletal record for South Asia so that clinal variation in space and time can be successfully identified, and continue to use these data to test anthropological and archaeological theories concerning diet, subsistence, health, demography, evolution, biological affinities and the cultural history of the Indian subcontinent.

Acknowledgements

The pioneering archaeological explorations of the late Dr. G.R. Sharma paved the way for this study, without his initial efforts this work would not have been possible and it was through his courtesy that we were able to conduct a preliminary examination of the dentition of the Sarai Nahar Rai and Lekhahia skeletal series. We extend our thanks to Drs. V.D. Misra, R.K. Varma, J. N. Pandey and D. Mandal for their involvement in excavations at Mesolithic Lake Culture sites. Allahabad University, Department of Ancient History, Culture and Archaeology graciously provided access to the valuable human skeletal collections, and extended the privilege of research affilliation and laboratory facilities to Dr. Lukacs. The co-operation and support of past and present heads of the department, Dr. U.N. Roy and Dr. S.C. Bhattacharya, is greatly appreciated. This research was completed with support from the American Institute of Indian Studies and a research grant from the National Geographic Society.

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The Pebble Tool Component of the Bonaigarh Neolithic Complex, Orissa

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Abstract

This paper discusses the significance and typo-technological features of pebble tools in the Bonaigarh Neolithic complex, Orissa.

Introduction

Although the pebble tool tradition in India started as early as the Lower Palaeolithic Period, its continuation as an important lithic component has recently been found in the Neolithic celt-manufacturing sites of the Bonaigarh sub-division of Orissa. The wide occurrence of these tools in the Neolithic sites of Bonaigarh not only denotes a distinct feature of this area but also suggests a cultural continuum of the early prehistoric cultures. In the present paper the author proposes to shed light on the techno-typological features of these pebble tools, their role in the cultural milieu and their distribution in the Neolithic industries of Bonaigarh.

The Area and the Sites

The Bonaigarh sub-division occupies the southern portion of Sundargarh District, in the northeastern hill regions of Orissa. Physiographically, it is an isolated hilly tract, surrounded by rugged forest-clad hill ranges and intersected by a few passes which connect it with the adjoining areas (Fig. 1). The river Brahmani, which originates in the Panposh sub-division, flows from north to south and dissects Bonaigarh into two almost equal parts. The river is joined by numerous tributaries which drain the narrow alluvial tracts. The tropical climate of the area, with an average annual rainfall of about 1647 mm, supports a dry deciduous forest which forms the habitat of a large number of wild animals, and provides a suitable economic base to the local aborigines (Senapati 1975).

During three seasons of exploratory work in the Bonaigarh sub- division (1985-1987), the author has been able to locate clusters of Neolithic celt-manufacturing sites. Most of them are in a primary context and have been found in two different geographical contexts, namely, sites on the alluvial surfaces of the river banks and those located in the foothill areas. The artefactual scatters, varying in area from a few square metres to a hundred square metres or more, have produced evidence for the manufacture of celts and a wide range of pebble tools. Each of these has been associated with numerous by-products such as lumps of raw material, hammerstones, flakes and cores.

With a view to understanding the nature and artefactual composition of these open-air sites, a detailed examination of the material evidence from thirteen representative clusters was carried out. Of these, seven sites, namely, Lodhani, Dhuri, Kantakudar, Ruguda, Mahuldiha, Balitakudar and Kandaipos are located on the river banks, and six sites, namely Bimalagarh, Jangra, Brahmanmara, Puranapani, Tendra and Khajuribahal are located in the foothill areas of Bonaigarh (Fig. 1). A site-wise percentage distribution of finished specimens of the celts and pebble tools (Fig. 2) clearly indicates that while a majority of the sites were used for the manufacture of celts, i.e., axes, chisels and adzes, it is noteworthy that pebble tools not only occur in most of the sites, but in some cases they even outnumber the tools of the celt category. The high proportion of pebble tools and their co-occurrence with the Neolithic celts and debitage suggests that this class of artefacts forms an inseparable part of the Neolithic culture complex of the Bonaigarh area, although this observation is yet to be confirmed stratigraphically.

The Pebble Tool Component

From the point of view of techno-typology, the following eight broad types could be distinguished among the pebble tools, namely, bored pebbles, chopper-chopping tools, unifacialy flaked pebbles, waisted flat pebbles, worked split pebbles, worked elongated pebbles, elongated knives and

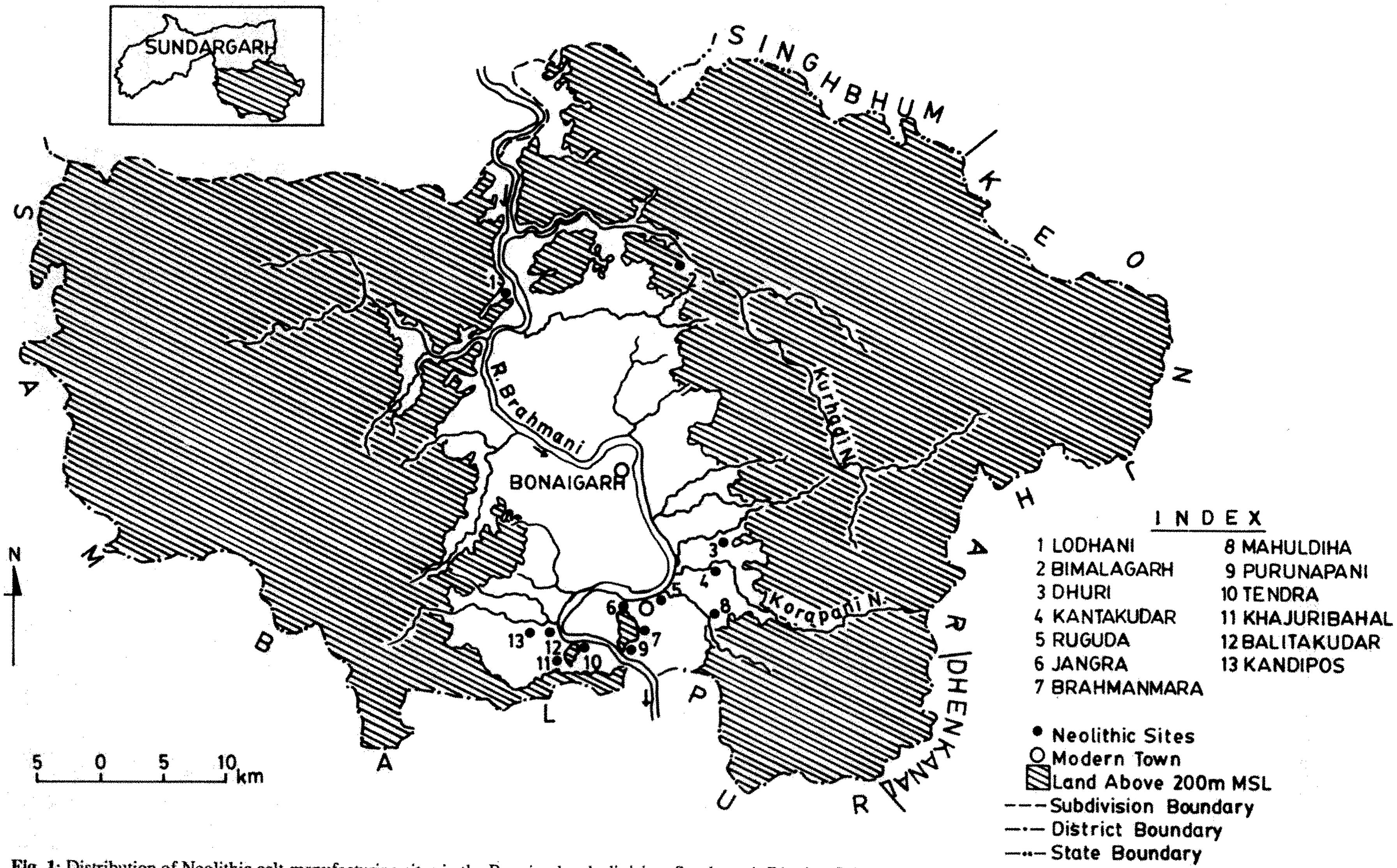

Fig. 1: Distribution of Neolithic celt-manufacturing sites in the Bonaigarh sub-division, Sundargarh District, Orissa

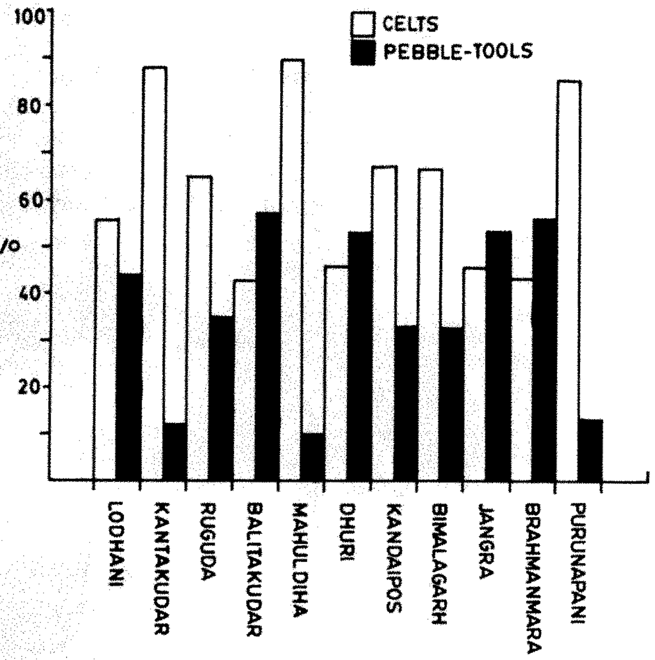

Fig. 2: Site-wise frequency distribution of celts and pebble tools

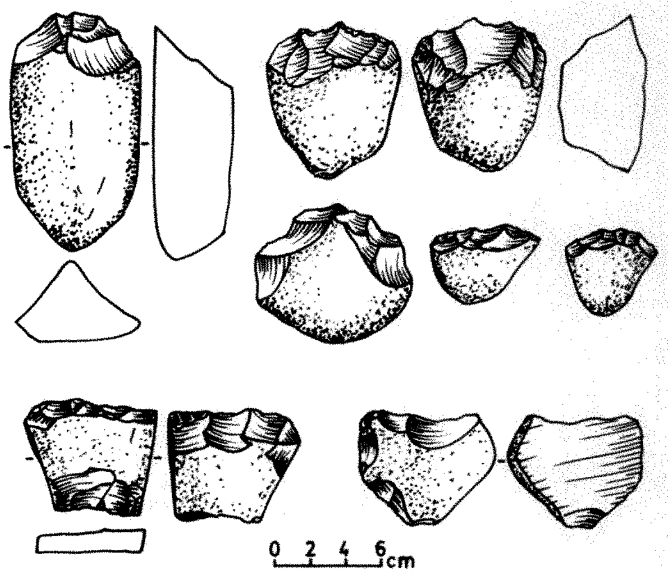

Fig. 3: Chopper-chopping tools

grain pounders. The techno-typological features of the above-mentioned tool types are discussed below and a site-wise distribution is given in Table 1.

Chopper-chopping tools

Tools of this category (Fig. 3) have been found in a majority of sites, except at Ruguda, Bimalagarh and Kandaipos. Out of a total of 46 chopper-chopping tools recovered from the ten clusters, 80.43% are made on dolerite, 6.52% on quartzite, and 4.35% each on chert, red-jasper and haematite. This lithic raw material is readily available in the nearby river beds in the form of pebbles.

The fairly high proportion (47.92%) of the tools of this group in the Bonaigarh Neolithic complex is significant. They are variously made on flat-based (76.09%), round-based (15.22%) and split pebbles (8.705), of which the flat-based chopper with convex working edge is predominant (54.35%). The occurrence of tools on split pebbles in the Neolithic context is particularly interesting since they are

Table 1: Site-wise distribution of pebble tools in the Bonaigarh Neolithic complex

Sites	A	B	C	D	E	F	G	H	Total	%
Lodhani	5	5	1	—	—	—	—	—	11	11.46
Kantakudar	2	1	—	—	—	—	—	—	3	3.12
Ruguda	—	—	—	6	1	—	—	—	7	7.29
Balitakudar	3	7	2	—	—	—	—	—	12	12.50
Mahuldiha	1	—	—	—	—	—	—	—	1	1.04
Dhuri	6	2	—	—	—	—	—	—	8	8.33
Kandaipos	—	1	—	—	—	—	—	—	1	1.04
Bimalagarh	—	1	—	—	—	2	—	—	3	3.12
Jangra	2	3	—	—	1	—	1	—	7	7.29
Brahmanmara	21	2	—	—	1	—	1	1	26	27.08
Purunapani	2	1	—	—	—	—	—	—	3	3.12
Tendra	3	5	4	—	—	—	—	—	12	12.50
Khajuribahal	1	—	—	—	1	—	—	—	2	2.00
Grand Total	46	28	7	6	4	2	2	1	96	99.97
Percentage	47.92	29.17	7.29	6.25	4.17	2.08	2.08	1.04		

A — Choppper-chopping tools; B — Bored pebble; C — Unifacially flaked pebble; D — Waisted flat pebble
E — Worked split pebble; F — Worked elongated pebble; G — Grain pounder; H — Elongated knife

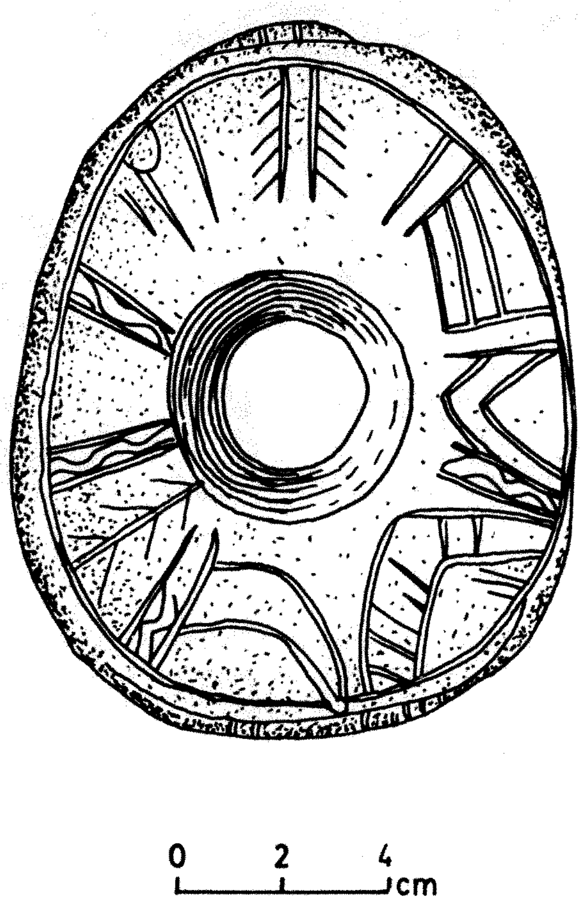

Fig. 4: Engraved bored pebble

characteristic of the Early Soan industry (De Terra and Paterson 1939). However, unlike on their Lower Palaeolithic counterparts, the working on these tools is generally neater and more regular. The majority of the chopper-chopping tools (50%) feature edge-angles that are below 70° followed by those between 70° and 80° (32.61%) and only 17.39% exhibit edge-angles above 80°. It may be recalled that the choper-chopping tools of the Lower Palaeolithic period generally have steep (angle above 80°) cutting edges (Pant 1982).

Most of the chopper-chopping tools of Bonaigarh fall within the length range of 60-89 mm (60.87%), and the width range of 50-79 mm (63%). This means that narrow pebbles were generally not preferred for manufacturing such tools. A majority (76%) of these tools have a thickness range of 30-49 mm.

Bored pebbles

This tool is also known as a ring-stone, mace-head or perforated stone, and has been associated with a large number of Neolithic manufacturing sites in Bonaigarh. Out of a total of 28 specimens, 60.71% are made on sandstone pebbles, 21.43% on dolerite, 7.14% each on quartzite and haematite, and only a solitary piece on phyllite. The one made on phyllite shows engraved designs on both the surfaces (Fig. 4). Except for the bifacial boring and sometimes grinding and smoothening of the surfaces, these artefacts are not completely perforated. Instead, they include a large proportion of specimens in which the perforation is incomplete.

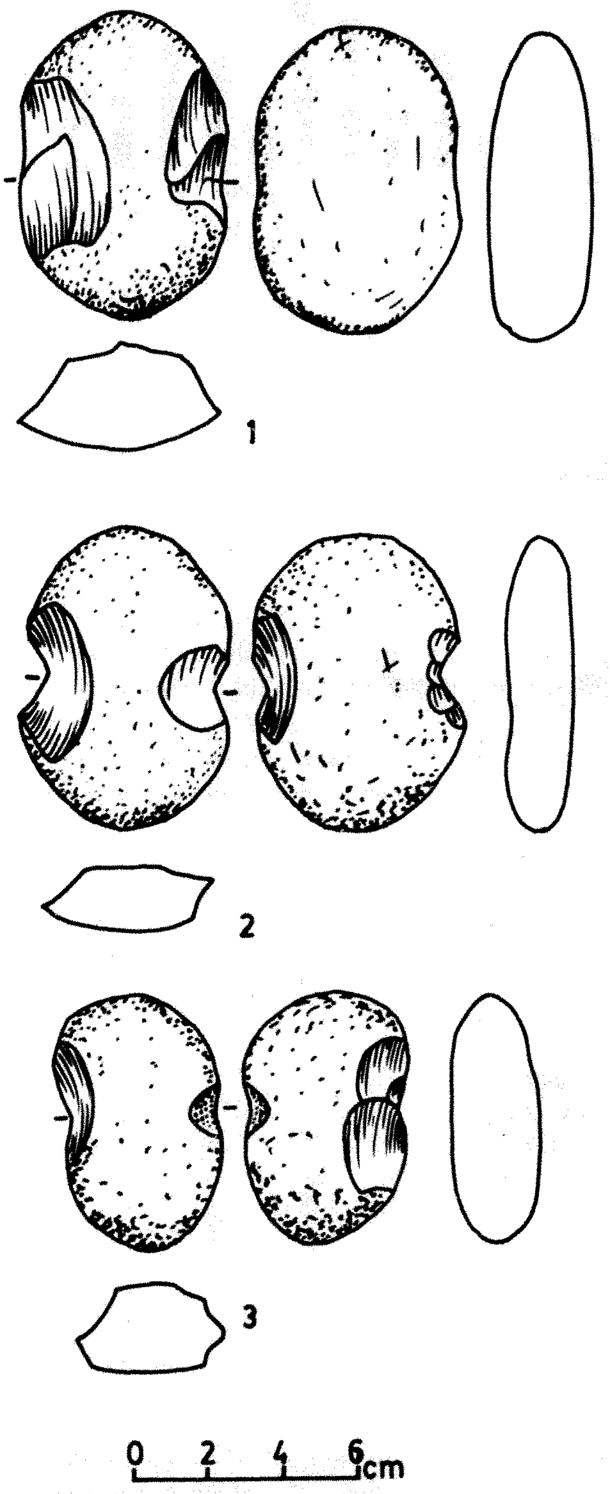

Fig. 5: Waisted flat pebbles

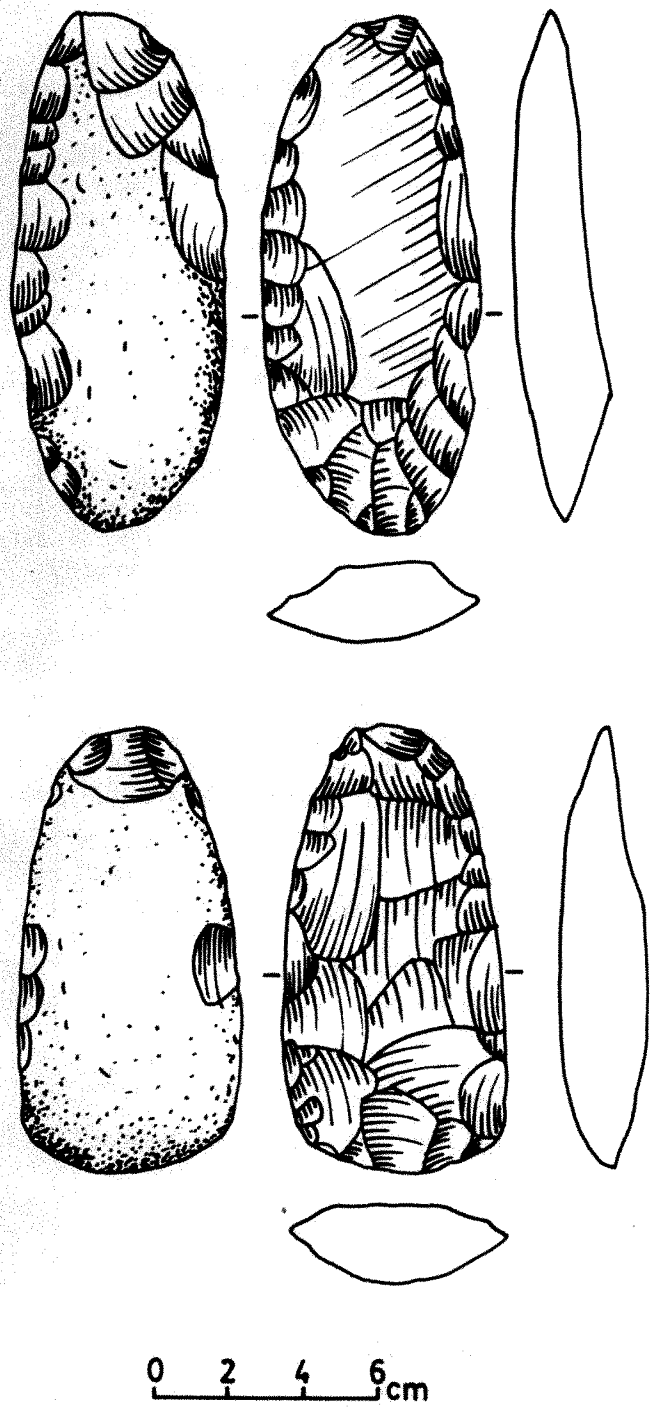

Fig. 6: Unifacially flaked pebbles

The length, width and thickness of the bored pebbles vary from 146-168 mm, 118-168 mm, and 60-127 mm, respectively. The outer circumference of the biconical bored holes ranges between 33 and 58 mm.

Waisted flat pebbles

These artefacts (Fig. 5) were collected from only one cluster at Ruguda, which also yielded axes, chisels and other implements. These flat, oval or sub-rounded pebbles are very often characterised by alternately notched lateral sides. In some cases the notches were made by bifacial flaking. However, on one specimen instead of the notch, a groove has been made on one of the sides (Fig. 5: 3).

Judging by their fairly uniform morphology and sizeable occurrence at one site, it is only reasonable to presume that these waisted pebbles were used for a special purpose. Similar artefacts have also been reported from southwest Africa (Sandelowsky 1971), Australia and East Asian countries (White and O'Connell 1982) and are found in association with Mesolithic or Neolithic contexts. Very often such tools have been interpreted as fish-net sinkers. However, this interpretation is inapplicable to the tools from Bonaigarh, for they are too small and too light to be effectively used as net sinkers in a turbulent river like the Brahmani.

The raw materials used for the manufacture of these specimens include dolerite, quartzite and quartz pebbles. The length, width and thickness of the available specimens fall in the range of 73-101 mm, 47-78 mm and 20-31 mm, respectively.

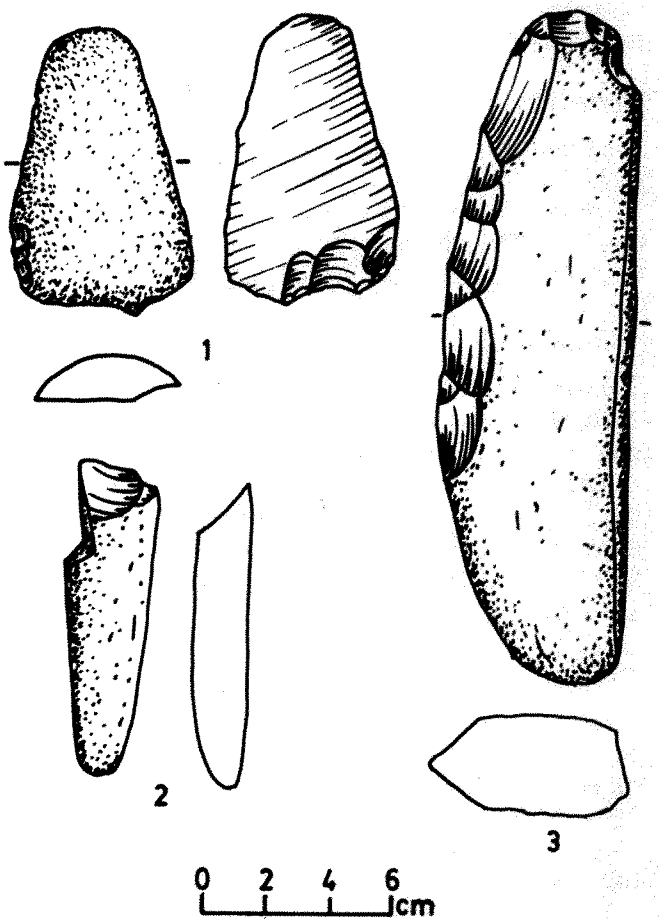

Fig. 7: Various other pebble tools of the Bonaigarh Neolithic complex

Unifacially flaked pebbles

This is a unique tool type that has been recovered from as many as four sites. It is generally made on an elongated, thin dolerite pebble, the dorsal surface of which has been thoroughly worked from all sides, while the ventral surface remains unretouched or partially worked (Fig. 6). Similar tool types have also been reported from several Holocene sites in the Kathmandu Valley of Nepal (Corvinus 1985) and also from a large number of Early Hoabinhian sites in Thailand, Burma and Vietnam (Tweedie 1953).

The seven specimens collected from the three workshop sites, fall in the length, width and thickness range of 135-179 mm, 71-142 mm and 43-110 mm, respectively. Both the ends of this implement are generally convex, while the cross-section is either plano-convex or roughly biconvex.

Worked split pebbles

A total of four specimens of this type have been collected from four workshop sites. In all the cases thin pebbles of black chert have been selected so that they can be split, and the plain split surface of the working ends bears marks of retouching (Fig. 7: 1). They resemble axes, and are generally triangular, with convex or straight working edges and a plano-convex cross-section. Their length and width vary from 53-88 mm and 10-21 mm, respectively.

Worked elongated pebbles

In all, only two specimens, made on narrow elongated pebbles of dolerite were collected from Bimalagarh. Both are characterised by broad flake scars on their working ends (Fig. 7: 2). Their length, width and thickness measure 96x29x18 mm and 63x29x20 mm, respectively.

Grain pounders

These are made on squat, thick dolerite pebbles having uniformly smooth surfaces. The cross-section is roughly sub-rounded, and the circular ends are faceted by radial flaking. The length, width and thickness of the two available specimens measure 60x57x47 mm and 79x69x50 mm, respectively. The smooth surface of this implement could have been effectively used for crushing or grinding cereals and nuts.

Elongated knife

There is a solitary specimen of this type, collected from Brahmanmara. It is an elongated, flat, massive dolerite pebble having one straight, blunt, cortexed side, while the other is sharp, bifacially retouched and convex in outline (Fig. 7: 3). It measures 208x61x33 mm in length, width and thickness, respectively.

Discussion

The foregoing inventory of artefacts from the Bonaigarh Neolithic complex clearly shows that the pebble tool component played a vital role in the local economy. We have also learnt from various ethnographic sources that even today tribes adopted to diverse forest environments, like the Bushmen of the Kalahari (Lee 1979), Australian Aborigines (Hayden 1979), New Guinea Highlanders (Steensberg 1980) and the Bindibu and Pitjantjatjara tribes of Australia (Thomson 1964), use a broad spectrum of pebble tools in activities such as cutting, chopping, scraping, splitting, pounding, grinding, etc. It is possible that the Neolithic pebble tools of the Bonaigarh forests might have been utilised for similar activities. It may be recalled that the occurrence of pebble tools of various categories has been confirmed by excavations as well as explorations at a few Mesolithic settlements in the neighbouring districts of Phulbani (Ota 1982-83) and Keonjhar (Mohanty 1985) in Orissa. It may be noted that these Mesolithic settlements also appear to be closely associated with a forest ecology. Thus, the association of various types of pebble tools with the Neolithic complex in Bonaigarh can be regarded as a continuation of the earlier tradition. It is a matter of common knowledge that the Hoabinhian industries of South East Asia are characterised by a dominant pebble tool component (Gorman 1971), and they are mostly located in forested regions.

On the basis of the archaeological and ethnographical data cited above, it can be argued that the occurrence of pebble tools either in the Mesolithic complex or in the Neolithic complex in Orissa is a local phenomenon and need not necessarily be interpreted as an extension of Hoabinhian influence on them.

Acknowledgments

The author thanks Prof. P.C. Pant for his valuable suggestions on the draft of this paper.

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Faunal Remains: An Application of Contingency Tables[1]

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Abstract

The aim of this paper is to demonstrate the usefulness of the contingency method to understand patterns of bone assemblages with respect to comparisons within a single site and comparisons among different sites.

Introduction

An important aim of the quantification of faunal material is to be able to identify the animals present in man's immediate environment and to identify the pattern of his preference, if any, for a particular species. The species structure of archaeofauna is then also compared among different sites, cultures and periods. The method of application of two dimensional contingency tables and the subsequent analyses of residuals were tested to obtain data on the species preference shown by early farming communities in Western India. Two dimensional R x C tables were prepared for both wild and domestic species. Any significant positive residual for domestic species can be taken as its preference over other domestic animals; while a significant amount of residuals for wild animals indicates the differential availability of wild animals around the site or the occurrence of specialized hunters.

A glance at the subsistence pattern of the various protohistoric cultures of western India reveals that the degree of animal resource utilization was highly variable. The emphasis on the use of domesticated animals or wild fauna varies from culture to culture and at different sites. Several non-parametric statistical methods are available to quantify the degree of the utilization of animal resources by ancient people (Sokal and Rohlf 1969). One of the important methods of quantification that can be applied to data containing frequencies of types and/or categories (e.g. bones,bone tools, etc.), is the method known as the 'R x C' Contingency Table (Everitt 1980).

It is a common feature of many archaeological reports that the animal remains are expressed in terms of simple percentages of the number of identifiable specimens (NISP). This is largely because the number of bones recovered, for instance, from the excavations of the Chalcolithic cultures of Western India, run into several thousands (Thomas 1988), and the method of percentages is a quick way of summarizing the data. The calculations involved are fewer and more simple, but the method is crude and cannot provide much information for comparative studies (Croxton *et al.* 1973). The method of the contingency table works on the principle of proportions and this is useful for comparing the proportions that emerge from two or more sites/cultural phases or any other suitable archaeological unit.

Method

Contingency tables use the raw frequency data (in this case, counts) and not the percentages calculated from the original counts of specimens (in this case, NISP).

'R' stands for the number of rows and 'C' stands for the number of columns in the contingency table. The available raw data of NISP are re-arranged into rows and columns and thus converted into a two dimensional table. The species (or suitable taxonomic unit of the worker's choice) can form the rows and the archaeological unit (as site or cultural phase) can form the columns.

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[1] A part of the data used here was included by the authors in a paper presented at the 1990 IACZ Conference in Washington D.C., U.S.A.

Table 1: Format of a contingency table

	Columns	**c = 1 to j**		**Column Total**
Rows	O11	O12	O13 .... O1j	T*1
r =1	O21	O22	O23 .... O2j	T*2
to r	O31	O32	O33 .... O3j	T*3
	.	.	. ...	.
	.	.	. ...	.
	Oi1	Oi2	Oi3 .... Oij	T*i
Row Total	T1*	T2*	T3* .... Tj*	N**

N** is the grand total of all row totals or all column totals

Once the raw counts of bones are entered into the table at the appropriate cells, the raw numbers are now called observed frequencies (Oij). The next step , using the observed frequencies, is to calculate the expected frequencies of the bones in each cell. The expected frequencies (E_{ij}) are calculated using the following formula:

$$E_{ij} = (T_{*i} \times T_{j*}) / N_{**}$$

$$= \text{(column total x row total) / grand total}$$

The expected frequencies are entered into a separate table similar to the one for observed frequencies. For each cell the statistics called chi-square (χ^2) is calculated using the formula given below and then entered in another table:

$$\chi^2 = (O_{ij} - E_{ij})^2 / E_{ij}$$

The chi-square values calculated for all the cells are pooled into one composite value of chi-square denoted by χ^2 cal.

$$\chi^2 \text{cal.} = \Sigma\, (O_{ij} - E_{ij})^2 / E_{ij}$$

The calculated value of chi-square is then compared with the standard value given in the statistical table (Fisher and Yates 1943) which is denoted by x^2 tab. This comparison is used to obtain the significance of the calculated value.

The working hypothesis of this method is that the proportions are uniform or equally distributed throughout the cells.The standard statistical tables provide the value based on the hypothesis of equality of proportions and the inferences drawn are as follows:

If χ^2 cal. > χ^2 tab. then the hypothesis of the equality of proportions is rejected.

If χ^2 cal. ≤ χ^2 tab. then the hypothesis of the equality of proportions is accepted.

The method of using two dimensional tables for archaeozoological data was first attempted by Lasota-Moskalewska and Sulgostowska (1976) and by Jasicki *et al.* (1962) for anthropological frequencies. Lasota-Moskalewska and Sulgostowska (1976) used this method to analyse the bones of domestic animals at one Swedish and 24 Polish archaeological sites. This method is used to understand the patterns of bone representation at several archaeological sites in Western India both for domestic as well as wild fauna. However, since the degree of bone fragmentation is different for wild animals from that of domestic animals, it was decided to treat the two groups separately.

Sites and Faunal Material

The observed counts of the identifiable specimens from various archaeological sites used in this paper are given in Table 2.

Comparison Within a Single Site

At Kaothe, three different locational units of the single cultural deposit were found and these were identified as KTE-I, KTE-II and KTE-III (Shinde 1985). In this case (Table 3) the columns represent the three localities (c=3) and the species form the rows (r=3) based on NISP values of the animal remains (Thomas and Joglekar 1990). Therefore this table now becomes a '3 x 3 table' for domestic species. The results of this contingency analysis (Table 3) show that the hypothesis of equality of proportions is rejected for domestic animals at the given level of error (i.e. denoted by the level).

Table 2: Sites and faunal material

Site	**Culture**	**Reference**
Tuljapur Garhi (TGL)	Chalcolithic	Thomas (1992)
Kaothe (KTE)	Chalcolithic	Thomas and Joglekar (1990)
Daimabad (DMD)	Chalcolithic	Badam (1986)
Nevasa (NVS)	Chalcolithic	Eapen (1960), Clason (1979)

Table 3: The '3 x 3 Table' for domestic animals at Kaothe

Species	Locality KTE-I	KTE-II	KTE-III	Total
Cow and Ox	1676	4739	1141	7556
Buffalo	22	63	7	0092
Goat/Sheep	163	501	86	0750
Total	1861	5303	1234	8398

χ^2 cal = 11.72
χ^2 tab = 11.14 at = 0.025

Similarly the NISP values for wild animals were studied using a '7 x 3 Table'. It was found that the proportions are not uniform over the three localities at Kaothe (Table 4).

Once it has been established that the pattern of bone representation is not uniform all over the site, the next step is to look for the locality or the species responsible for this non-uniformity (shown by cal).

Table 4: The '7 x 3 Table' for wild animals at Kaothe

Species	Locality KTE-I	KTE-II	KTE-III	Total
Nilgai	18	40	17	75
Blackbuck	52	87	18	157
Chowsingha	20	72	10	102
Sambar	2	32	7	41
Chital	4	17	13	34
Barking Deer	4	14	2	20
Wild Pig	5	11	4	20
Total	105	273	71	449

χ^2 cal = 40.64
χ^2 tab = 28.30 at = 0.005

Several methods are available to locate cells that deviate from the expected picture of equality of proportions (Kendall and Stuart 1966). The methods in brief are as follows:

(1) individual values of the chi-square for each of the cells are tested against the table value and the cells with greater value than the table value are selected;

(2) the difference between observed and expected frequency for each cell is expressed as the percentage surplus (only for +ve values) and arbitrarily the percentage is taken as being either greater than or within the limits of normalcy (Jasicki *et al.* 1962);

(3) the method of analysis of residuals described by Haberman (1973) is useful to obtain an objective inference about the surplus of counts in each cell. The method is more complicated than the method of percentage (%) surplus, where a quick glance at the cells can locate the culprit.

The non-equality of proportions for domestic animals can be interpreted in three different ways, as suggested by Lasota-Moskalewska and Sulgostowska (1976) and given below:

(1) negative values indicate greater bone fragmentation

(2) positive values indicate species preference

(3) zero indicates the absence of interaction between the species and the archaeological units, which in statistical terms is shown by the table value of chi-square.

In the case of the domestic species at Kaothe II, the percentage surplus for the buffalo is more than 5% and so can be taken as an indication of preference over other species at that locality (Table 5).

Table 5: Percentage surplus of bones for domestic animals at Kaothe

Species	KTE-I	Locality KTE-II	KTE-III
Cow and Ox	+0.02	—	+0.41
Buffalo	+1.75	+5.34*	—
Goat/Sheep	—	+3.65	—

* if % is more than 5%

A similar anlysis done for wild animals as an extention of Table 4 is given in Table 6, where an interesting pattern of percentage surplus can be noted.

Table 6: Percentage surplus of the bones of wild animals at Kaothe

Species	KTE-I	Locality KTE-II	KTE-III
Nilgai	+0.61	—	+6.85*
Blackbuck	+9.74*	—	—
Chowsingha	—	+9.78*	—
Sambar	—	+17.24*	+1.27
Chital	—	—	+22.41*
Barking Deer	—	+9.20*	—
Wild Pig	—	—	+14.20*

* if % is more than 5%

Explanations for the occurence of domestic animals is not valid for wild animals, because hunting may not involve a preference. The occurrence of wild animal bones at archaeological sites depends on the availability of the animals in the vicinity of the site. There are three possible explanations for the differential pattern of occurrence of wild animal bones within a single site.

(a) It is possible that at different localities a different set of wild animals was available to hunters in sufficient numbers. This is possible if different localities were occupied at different seasons as has been suggested for KTE-II (Shinde 1985).

(b) The fauna around the sites can be different at the same point in time, if the localities are away from each other. This alternative however, is not valid for Kaothe, since the three localities are within a few metres of each other (Shinde 1985) and thus within easy access.

(c) The third possibility is that essentially similar animals are found at all three localities, but the strategy of exploitation varied. Such differential utilization is possible if groups of people with different subsistence strategies lived in different areas at the same time. Specific territorial separations of hunting communities and the sharing of hunting space are not uncommon in many hunting tribes of the world (Coon 1972). At present several Indian tribes have taboos on eating the meat of certain animals. For instance, monkey's flesh is prohibited among almost all tribes, but the Birhors living in the Chota Nagpur area are specialists in hunting monkeys and only they eat its flesh (Coon 1972). The Kadars residing in the Nelliapathi Hills of Kerala do not touch the meat of bears and bison (Bhowmik 1971).

Similar ethnographic data are available on three non-pastoral nomadic communities of Maharashtra called the Nandiwallahs, Vaidus and Phase Phardhis. These three hunting groups live in the same area and hunt entirely different sets of animals. The three communities have peculiar methods of hunting and the species hunted do not overlap (Malhotra *et al.* 1983).

An alternative explanation to the differential presence of bones has been given by Wilson (1978), where the difference in densities was considered the result of taphonomic factors. However, this suggestion does not explain why, at Kaothe, there are more bones of goat/sheep in the central area than on the periphery of the site.

Comparison Among Different Sites

The use of contingency tables as a method is flexible and can also be used to understand the differences among several sites with respect to animal utilization. The faunal remains from four Chalcolithic sites in Maharashtra were used to try to understand the pattern of exploitation of domestic species. The results of the contingency analysis are given in Table 7.

Table 7: The observed counts of bones of domestic animals at Chalcolithic sites in Maharashtra

	Sites				
	TGL	**DMD**	**KTE**	**NVS**	**Total**
Cow/Buffalo	588	539	7648	300	9075
Goat/Sheep	94	69	750	56	969
Domestic Pig	11	02	20	05	38
Total	563	610	8418	361	10082

χ^2 cal = 75.35

χ^2 tab = 14.45 at 6 d.f. and = 0.025

TGL: Tuljapur Garhi DMD: Daimabad
KTE: Kaothe NVS: Nevasa

It is clear from the value of chi-square that the pattern of utilization of domestic animals at various Chalcolithic sites is not uniform. Table 8 gives the values of chi-square for individual cells and the percentage surplus is given in brackets.

Table 8: Chi-squares and the values of % surplus for Chalcolithic sites in Maharashtra

		Sites		
Species	**TLG**	**DMD**	**KTE**	**NVS**
Cow/Buffalo	2.05 (-)	0.18 (-)	0.66 (0.78)	1.90 (-)
Goat/Sheep	11.3 (1.1)	1.83 (-)	4.32 (-)	13.07* (2.2)
Domestic Pig	26.4* (22.1)	3.89 (0.8)	4.33 (-)	9.74* (9.6)

* if the cal for a single cell is more than 5.02 and the observed count is more than the expected count

The differential pattern of non-equality is the result of the presence of the bones of domestic pig, which are surplus by 22.1% at Tuljapur Garhi and by 9.60% at Nevasa. At Nevasa, goat/sheep bones were surplus by 2.20% The chi-square test for the corresponding cells shows that the surplus of pig and goat/sheep bones is statistically significant.

The analysis of residuals (Haberman 1973) confirms the results of chi-square analysis and shows that cow/buffalo bones were present in significantly greater numbers at Kaothe than at other sites (Table 9).

Table 9: Adjusted residuals for Chalcolithic sites in Maharashtra

Site	TLG	DMD	KTE	NVS
Cow/Buffalo	—	—	6.33*	—
Goat/Sheep	3.66*	1.46	—	3.87*
Domestic Pig	5.39*	—	—	3.18*

* if the value is more than 1.96

At Nevasa and Tuljapur Garhi, pig and goat/sheep may have been preferred to cattle, whereas at Daimabad no species was preferred. It is also interesting to note that a similar high occurrence of pig bones has been noticed at Mehrgarh (Meadow 1989) and was suggested to be an attempt at rearing pigs during that particular cultural phase. It is likely that ancient people might have preferred one type of animal over another depending upon its utility or adaptability to the environment as demonstrated by Thomas(1988).

Scope and Limitations of Contingency Tables

Contingency tables as a method can be used to study any material classified with a specific typology. The underlying assumptions, however, need to be checked before application.

(1) The method assumes that, a priori, the data does not have a collection bias. In the case of archaeological samples like bones or tools it is assumed that there is no special selection of a particular type of bone or tool. In other words the assemblage used for analysis is assumed to be free from the individual choice of the excavator.

(2) The method has provision for correction to adjust for the absence of frequency in any one of the cells, however in such a case, the power of the method is reduced. Details of correction procedures are given by Everitt (1980) and Goralski (1966).

(3) The method assumes that the classes on which the table is constructed are not overlapping. The rows and columns are assumed to have a random occurrence. In other words, if the classes have a certain interaction, this will result in a high value of chi-square statistics.

Conclusions

One can offer several possible explanations for the occurrence of differential bone assemblages. The presence or absence of a particular species in the archaeofaunal assemblage can be interpreted as an indication of variable subsistence strategies. Thomas (1988) has suggested environment-related changes in faunal exploitation strategies of sheep/goat and cattle pastoralism in ancient western India. At present there is no independent evidence available at Kaothe regarding the clusters of people or their ethnic composition. However, with the help of ethnographic data on hunting communities, one can draw inferences about ancient subsistance strategies. For instance at Kaothe, it is possible that different groups of people with hunting specializations occupied different areas of the ancient site. Therefore contingency tables help us to understand the significance of man-animal relationships based on spatial aspects.

Acknowledgements

The authors wish to thank Ms. Kathleen Ryan of the University of Pennsylvania for comments on the manuscript.

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The Faunal Assemblage and Subsistence Strategies at Tuljapur Garhi

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Abstract

The Vidarbha region of Maharashtra is well known for its Megalithic graves and Iron Age settlements. The site of Tuljapur Garhi is of special interest as it was the first Chalcolithic settlement excavated in the Vidarbha region. This culture can be dated from the late second to the first millennium B.C. The identification of faunal remains from Tuljapur Garhi has revealed the presence of fourteen species of animals including mammals, reptiles, birds and molluscs. Cattle predominate among the animals represented indicating their economic importance in the Chalcolithic culture. A large number of bone tools have also been found and were probably used for skinning animals, in the preparation of hides and also for wood processing. The type of wild mammals identified at Tuljapur Garhi suggest an open scrub jungle in the vicinity of the site.

Introduction

The Chalcolithic site of Tuljapur Garhi, (21° 10' N: 77° 35' E), is situated on the right bank of the river Purna, a tributary of the Tapi, in the Amravati district of Maharashtra. This site was excavated in 1984-85 by the Nagpur Excavation Branch of the Archaeological Survey of India under the supervision of B.P. Bopardikar. The mound measures 210 m N-S and 90 m E-W. The cultural deposit is about 1.5 m thick and comprises 4 layers. The entire deposit belongs to the Chalcolithic period, consisting of the Jorwe phase in layers (1) and (2) and the Malwa phase in layers (3) and (4).

The artefacts include a variety of wheel-made pottery with painted designs, steatite beads, beads of terracotta and semi-precious stones, microliths and bone tools. Copper objects such as rings, bangles and fish hooks were found only in the Jorwe phase. Elliptical and circular house plans have also been traced in both phases at Tuljapur Garhi (B.P. Bopardikar, personal communication).

A series of radiocarbon dates (half-life 5570 ± 30) are available (Table 1), based on charcoal samples from the habitation deposits. Some of these dates are enigmatic. However, based on the typology of the artefacts at Tuljapur Garhi, the culture can be dated from the late second to the first millennium B.C. This site is of special interest because it is one of the first Chalcolithic settlements excavated in the Vidarbha region of Maharashtra. These sites are usually concentrated in the western part of the State.

A botanical study has revealed that the early farmers at

Table 1: Radiocarbon dates based on charcoal samples from the Jorwe and Malwa phases of Tuljapur Garhi

Cultural Phase	Date	Location
Jorwe	2410 ± 100 years B.P.	Trench C1, Quadrant I, pit sealed by layer (1)
	3310 ± 90 years B.P.	Trench A4, Quadrant II, layer (1)
	340 ± 90 years B.P.	Quadrant IV, layer (2)
Malwa	2870 ± 100 years B.P.	Trench A1, Quadrant I, layer (3)

Tuljapur Garhi practised agriculture for two seasons during the year. They cultivated winter crops like wheat, barley, lentil, grass pea, gram, and summer crops like rice, great millet, hyacinth bean, horse gram, black gram and green gram (Kajale 1988). Altogether 15 species of plants have been identified at the site and the majority belong to the cultivated category.

Animal remains collected from all four layers are included in the present study. There is no uniformity in the collection as the area excavated varies considerably in the different layers. For instance, in layer 1 the animal remains were collected from 27 squares; in layer 2 from 16 squares; in layer 3 from 9 squares; and in layer 4 from 2 squares. The bones were heavily fragmented, and as most of the bones were encrusted with soil, they were subjected to mechanical and chemical cleaning.

Methodology

The identification of excavated bones was carried out with the help of the reference skeletons of modern domestic and wild animals housed at Deccan College and the faunal material from all four layers was studied separately. The distribution of animal remains in each layer has been plotted in a tabular form (Thomas, in press). However, to aid interpretation of the economic importance of animals at the site, the bones have to be quantified. Several methods are employed for quantification but, because of the small size of the sample, the total counts of the number of identifiable bones of each species (NISP) are taken into consideration (Table 2). Here the vertebrae and ribs are not included since they cannot be identified with certainty. The age of the animals at death is calculated by the pattern of eruption and wear of the teeth, and by the epiphyseal fusion of long bones.

Animals

Fourteen species of animals have been identified at Tuljapur Garhi, including mammals, reptiles, birds and molluscs. Among the mammals identified at the site the domesticated species include:

1. Cattle (*Bos indicus*)
2. Goat (*Capra hircus*)
3. Dog (*Canis familiaris*)
4. Ass (*Equus asinus*)
5. Four-horned Antelope (*Tetracerus quadricornis*)
6. Chital (*Axis axis*)
7. Hog Deer (*Axis porcinus*)
8. Wild Pig (*Sus scrofa cristatus*)
9. Mongoose (*Herpestes edwardsi*)
10. House Rat (*Rattus rattus*)
11. Fowl (*Gallus* sp.)
12. Great Indian Bustard (*Ardeotis nigriceps*)
13. River Turtle (*Chitra indica*)
14. Bivalves (*Lamellidens* sp.)

Cattle predominate among the animals represented at Tuljapur Garhi. These animals have been identified from all the layers represented by almost all the skeletal parts. The heavy fragmentation of bones at the site may have been due to human activity, since cut marks and charring are noticed on many of the bones. In general, for meat, this animal is preferred at a young age. This is evident from the unfused epiphyses of long bones and the mandibles bearing just erupted or erupting third molars, thus indicating that the age of these animals was around three years when they were killed. However, a few worn out teeth of old animals are also found in the collection, suggesting the probability that some of these animals were used for agricultural operations and/or breeding purposes (Thomas 1984a). Cattle bones represent more than 70 % of the total faunal assemblage from each

Table 2: The percent frequency of identifiable bones of animals in layers 1-4 at Tuljapur Garhi

	Layers (1)	(2)	(3)	(4)
Cattle (*Bos indicus*)	71.93	72.45	76.40	91.53
Goat (*Capra hircus*)	14.16	8.68	8.99	—
Dog (*Canis familiaris*)	1.16	1.53	1.69	1.69
Ass (*Equus asinus*)	0.93	—	—	—
Four-horned Antelope (*Tetracerus quadricornis*)	1.62	5.10	7.87	6.78
Chital (*Axis axis*)	1.62	5.61	2.81	—
Hog Deer (*Axis porcinus*)	3.48	—	—	—
Wild Pig (*Sus scrofa cristatus*)	0.93	2.55	1.12	—
Mongoose(*Herpestes edwardsi*)	0.46	—	—	—
House Rat (*Rattus rattus*)	0.23	—	—	—
Great Indian Bustard (*Ardeotis nigriceps*)	—	2.04	—	—
Fowl (*Gallus* sp.)	2.55	—	—	—
River Turtle (*Chitra indica*)	—	0.51	—	—
Bivalves (*Lamellidens* sp.)	0.93	1.53	1.12	—

layer. However, in layer (4) although their frequency is 91.53% (Table 2), this over-representation may be due to the smaller area excavated in this layer. The high frequency of cattle in all the layers indicates their economic importance in the Chalcolithic culture at Tuljapur Garhi.

The goat is the second most important animal in the food economy. Its bones have been found in the first three cultural layers (14.16%, 8.68% and 8.99% respectively),but are absent in the fourth layer. However, this absence cannot be confirmed at present. It seems that goats were not part of the daily diet of the people, however the large quantity of the bones of this animal in layer (1) should be noted.

The dog is known as man's companion right from prehistoric times. Dog bones are identified at Tuljapur Garhi in all four layers, represented by metapodia and parts of the jaw. There was no evidence of deliberate modification of these bones as they were not part of the diet of the people. The dog bones may have been brought back into the settlement by scavenging animals.

Among the wild animals represented at Tuljapur Garhi the four-horned antelope (*Tetracerus quadricornis*) was one of the major sources of animal protein. This animal is identified by its axial and appendicular skeleton, with frequencies of 1.62%, 5.10%, 7.87% and 6.78% in layers (1), (2), (3) and (4) respectively. Another animal consumed was the Chital (*Axis axis*) whose representation in the first three layers is 1.62%, 5.61% and 2.81% respectively. Some of the antler fragments collected at the site may have been used for making tools. The Hog Deer (*Axis porcinus*) is rarely found in archaeological contexts. However, this animal is represented by about 15 bones in layer (1) at Tuljapur Garhi. An antler fragment of a Hog Deer which was broken just above the 'burr', and probably used as a tool, was found in the collection. The Hog Deer antler differs from that of the Chital by its slenderness, elongated bony pedicel and straight main beam.

Wild pigs were hunted by the people of Tuljapur Garhi. Pig bones are found in the first three layers, mostly represented by fragments of mandibles and maxillae. One of the major changes that took place in this animal due to domestication is a general reduction in size. Because of the considerable shortening of the snout region of the skull, the dentition in the domestic pig has become smaller both in the upper and lower jaws. The canines and molars identified at the site show the typical characteristics of wild pigs.

The Mongoose (*Herpestes edwardsi*) was also hunted for food as charred bones were found in the collection. Because of the small size of this animal it is seldom found in archaeological excavations (Thomas 1984b). By contrast, the common house rat (*Rattus rattus*) is a burrowing animal and is found almost everywhere in archaeological deposits (Thomas 1975). The rat bones at Tuljapur Garhi may not be contemporary with the Chalcolithic culture, rather they may be later intrusions into the deposit. Two species of birds, the Great Indian Bustard (*Ardeotis nigriceps*) and jungle fowl (*Gallus* sp.) are represented in layers (2) and (1), respectively.

It appears that turtle meat may have been relished by the inhabitants. A solitary example of the carapace of a River turtle (*Chitra indica*) is noticed in layer (1). It is not certain that the shells (*Lamellidens* sp.) identified at Tuljapur Garhi constituted food refuse, although this particular species is edible and consumed by many people even today. No other use was made of this shell at the site. Bangles were made on chank shell (*Turbinella pyrum*). Fish remains are absent from the collection despite the proximity of the site to the Purna river and the presence of fish hooks in the Jorwe phase.

Discussion and Conclusion

The entire faunal assemblage from Tuljapur Garhi was studied. According to the excavators, two main cultural phases, the Malwa and the Jorwe, could be distinguished. The absence of animals like goats, pigs, smaller mammals, birds and reptiles in the Malwa phase, especially in layer (4), cannot be confirmed at present.

Domesticated Species

As in the other protohistoric cultures of India, humped Indian cattle is the dominant species at Tuljapur Garhi. Cattle were killed for food both in the Malwa and Jorwe phases. In addition to this regular supply of meat, cattle may have also helped the early populations in a number of ways. By-products like milk, dung and hide are economically very valuable and may have been utilized by the Chalcolithic population (Thomas 1989). Cattle may have also been used for agricultural purposes. The introduction of the wheeled cart in the evolution of technology is associated with the domestication of cattle. One of the earliest examples of a wheeled cart is from Mohenjo-daro where a terracotta wheeled toy cart is shown being pulled by bullocks (Allchin and Allchin 1968). Similar evidence is also reported at Inamgaon where an engraving of bulls and a cart is depicted on a storage jar in the Jorwe phase (Dhavalikar *et al.* 1988). This evidence suggests the use of cattle for traction from very early times in India. Even at Tuljapur Garhi, as double cropping was practised at the site, cattle may have helped in the agricultural activities (Kajale 1988).

Another point of interest is the considerable increase in the frequency of goat bones in layer (1), compared to those of other animals at Tuljapur Garhi. The presence of the ass (*Equus asinus*) is also noticed in this layer. More or less similar evidence is found during the late Jorwe phase (1000-700 B.C.) at Inamgaon (Thomas 1988). At Inamgaon the change in the composition of animals in the late Jorwe phase is also associated with a decline in agriculture and in general economic conditions, probably due to severe environmental degradation during 1000-700 B.C. The late Jorwe people at Inamgaon had cultural contacts with the contemporary Iron Age population of this region. This kind of contact with surrounding Iron Age sites cannot be conclusively proved for Tuljapur Garhi until the site is extensively excavated.

The dog remained a companion of Chalcolithic man throughout the history of Tuljapur Garhi. This animal may have guarded the settlement and the domestic herds of the inhabitants.

Wild Animals

The proportion of domestic to wild animals killed at the site is approximately 4:1. At Tuljapur Garhi the wild mammals, and the aquatic and avian fauna may have supplemented the food economy which was based on agricultural produce and a regular meat supply from domestic animals. Fishing may have also been practised as the site is on the bank of the river Purna. However,there is no direct evidence for this. In the majority of Iron Age settlements, especially from the Vidarbha region of Maharashtra and some of the adjoining Chalcolithic cultures of Central India, pig bones (both wild and domestic) were found in abundance. Indeed they were the second most important animals in the food economy after cattle. However, at Tuljapur Garhi there is no evidence for the domestication of pigs, though wild pig bones are found in the collection. Probably for a well-settled early agricultural society domestic pigs may have been a nuisance as they destroy crops. The wild mammals identified at Tuljapur Garhi are suggestive of an open scrub jungle in the vicinity of the site.

Butchery

The major fragmentation of the bones at this site may have been due to human activity and the cut marks on the bones suggest the use of a metal tool. Representation of both meat bearing and non-meat bearing parts of the bodies of the animals at the settlement suggests butchering of these animals in the habitation area. Charring is observed only on a few bones, suggesting that the animals were defleshed before cooking.

Bone Working

A large amount of worked bones and bone tools were collected at the site and most of them may have been used for skinning the animals, in the preparation of hide and also in wood processing. Points and scrapers, mainly manufactured by chipping and grinding, abound in the collection. Occasionally the points were fire-hardened at the working tip of the tool.

The Vidarbha region of Maharashtra is well known for its Megalithic graves and Iron Age settlements and a number of such archaeological sites have been reported from this region (Deo 1985), though the site of Tuljapur Garhi remains of special interest since it was the first Chalcolithic settlement excavated in Vidarbha. Further excavation of similar sites, such as Adam, will expand our knowledge of the Vidarbha Chalcolithic settlements.

Acknowledgements

I am grateful to Mr. B.P. Bopardikar, retired Superintending Archaeologist of the Archaeological Survey of India, Nagpur for entrusting me with the faunal remains from Tuljapur Garhi. Thanks are also due to Ms. Kathleen Ryan of the University of Pennsylvania for comments on the manuscript.

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Faunal Background of the Iron Age Culture of Maharashtra

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Abstract

Very little is at present known about the settlements of the Iron Age populations or of the Megalithic builders of western India. However, recent excavations in Vidarbha have brought to light a variety of Megalithic burials and a few settlement sites. With the available faunal evidence from these excavations, it is presumed that the inhabitants were the first horse breeders in this part of the country. Horses (*Equus caballus*) have been occasionally reported from the terminal phases of the Indian Neolithic/Chalcolithic cultures, which may be contemporary with some of these Iron Age cultures. The Megalithic settlements of the Vidarbha region can be approximately dated between 900-300 B.C. A majority of the Megalithic graves have yielded partial burials of horses consisting of the skull and the lower extremities of the limb bones. The sacrificed horses were in the age group of 3-6 years with no selection by sex. Since not all graves contained horse bones, it is suggested that horse sacrifice was not an essential ritual among these people, rather it was a symbol of high status. Faunal evidence from associated settlement sites points to a mixed economy of stock-breeding (predominantly cattle), hunting and dry farming. Some horse remains were found in food refuse contexts suggesting that horse flesh may have been consumed as part of the sacrificial and burial ceremonies.

Introduction

The Iron Age in western India, especially in the state of Maharashtra, is associated with megalith building activities which can approximately be dated to 900-300 B.C. During the last few decades, more than 1400 Megalithic sites have been reported from all over India. One thousand one hundred and sixteen of these are located in peninsular India (Deo 1985), and about 90 Megalithic sites are reported from Maharashtra. However, only about 15% of these are excavated. Different types of Megalithic monuments are encountered in different regions. Stone circles with cairn fillings are predominantly represented in Maharashtra. A majority of these sites are located in the hilly and forested areas in the eastern districts like Bhandara, Nagpur and Chandrapur. It appears that apart from topographical considerations people preferred this region for the availability of raw materials like iron, coal and manganese.

Despite the large number of Megalithic burials, there are very few settlement sites. However, excavations by S.B. Deo in Vidarbha have brought to light some aspects of the Megalithic traits in this region. His main work includes Tekalghat Khapa (1970), Mahurjhari (1973), Naikund (1982), Borgaon (in press), Khairwada (in press), Bhagimohari (in press) and Hingna Raipur (in press). Of these Tekalghat Khapa, Naikund, Bhagimohari and Khairwada are settlements while the others are purely burial sites.

Megalithic Burials

The Vidarbha Megalithic burials are typical cairn fillings. Along the periphery of the burials huge boulders are arranged in a circle. The graves are filled with pebbles and clay and occasionally only with pebbles. Usually a smaller circle or a rectangular chamber is made with smaller boulders within the big circle. Artefacts and skeletal material are scattered all over the graves without any specific pattern. They include pottery, copper, iron, gold and stone objects, beads, horse bones and human skeletal remains. Micaceous Red ware, Black-on-Red ware, Painted Black-and-Red ware and Gray ware are the main types of pottery encountered. Copper objects consist of horse ornaments, lamps, bowls, lids, bangles, anklets, etc. Weapons like spearheads, swords, daggers, arrowheads, as well as tools such as chisels, axes, adzes and sometimes hoes are all made of iron. Gold earrings are occasionally found. A variety of beads of agate, chalcedony and steatite are also present. Stone objects include saddle querns and pounders. Partial and complete human burials are found in some graves; those without human burials may be symbolic in nature.

Nearly 50 burials have been excavated and the faunal remains from a majority of these sites have been studied by the author. Animal and human remains were found only in a few of the excavated graves. The bones were in a very bad state of preservation and it was difficult to retrieve them from the sticky clay, which turned hard on exposure. Faunal remains consist mainly of partial burials of the horse in the form of the skull and the lower extremities of the limb bones.

At Naikund in the Nagpur district of Maharashtra, six burials have been excavated. Identifiable bones have, however, been found in only two of these graves (Badam 1982; Thomas, in press). From locality IV, Megalith No. 13, cattle bones have, for the first time been found in a grave. Although these bones had been cut in different places probably to make them into smaller pieces, they comprise a mandible and a complete set of the hind legs of a bull with portions of the pelvis. This is the only evidence for the burial of an animal other than the horse which has so far been discovered in the excavated Megalithic graves in Vidarbha.

At Mahurjhari, Nagpur District, 12 Megalithic graves were excavated and horse remains have been retrieved from four of them (Megalith Nos. 3, 7, 11 & 29). The assemblage here was better preserved than at the other sites. Megalith No. 3 yielded the complete dentition and a few phalanges of a stallion. From the crown pattern of the teeth and their wear, it appears that the animal was 5-6 years of age. Megalith No.11 has also yielded the complete dentition of a horse without the canine teeth, which suggests that it was probably a mare. The age of this animal at death would have been around 4-5 years. In the other two graves, isolated tooth fragments and a few bones of a horse around 5-6 years were found. Sex determination was not possible on these remains (Thomas, in press).

At Borgaon, Nagpur District, 47 Megalithic graves have been recorded, but only 5 have been excavated. Megalith No. 3 yielded horse remains from the N-E quadrant (Thomas in press). Neither aging nor sexing were possible as the remains were very fragmentary. Isolated human teeth have also been reported from this grave.

Another important discovery was at Khairwada in Wardha District, where more than 1500 Megalithic circles are scattered over an area of 0.75 km². Of these, 5 graves have been excavated, and three have yielded horse remains from the S-E and N-E quadrants of the circles (Megalith Nos. 1 & 2 in locality I and No. 1 in locality III). From the dental remains it appears that these animals were 4-5 years of age (Thomas in press).

The faunal evidence suggests that the Megalithic builders sacrificed horses and subsequently parts of the animals were placed in the graves. This may not, however, have been obligatory, since only a few of the excavated burials have yielded horse remains. This practice may have been a status symbol or one connected with the profession of the deceased.

Megalithic Settlements

Four important settlement sites have been excavated in the Vidarbha region of Maharashtra (Deo 1985). The Megalithic habitation site at Bhagimohari is on the right bank of the river Kolar in Nagpur District. The mound is fairly extensive measuring about 5 hectares and the deposit is approximately 2.5 m thick, consisting of 9 layers. Seventeen species of animals including mammals, birds, reptiles and molluscs were identified (Table 1).

Cattle constituted a major part of the faunal assemblage at Bhagimohari. The bones were charred and found to have cut marks. The presence of an almost equal number of meat bearing and non- meat bearing parts of the body suggests the slaughtering of these animals at the site. The presence of some old bulls in the collection implies that some of these animals may have been used for agricultural operations or for breeding purposes (Thomas and Joglekar 1990). Evidence is lacking for the consumption of horse meat at Bhagimohari. However, the teeth of this animal were found along with other kitchen refuse. Birds and molluscs played an important role in the food economy, and it appears that the snaring of birds or bird hunting was a major activity (Thomas in press).

A large number of bone tools made on the long bones of ruminants, mostly cattle, were also retrieved. The techniques employed were chipping and grinding, but predominantly grinding. Tools include a variety of points, awls and scrapers, which might have been used in butchering, the preparation of hides, and for many other purposes. Some of the shells collected had holes drilled in them and were probably used as pendants.

Khairwada is situated on the right bank of the river Dham in Wardha District. The present-day village is situated over the Megalithic habitation. A small-scale excavation was conducted near a school building and the habitation deposit was found to be approximately 2 m thick, consisting of 6 layers. Sixteen species of wild and domestic animals were identified at the site (Table 1). As the excavation was of a very limited nature, nothing could be concluded from the animal remains from Khairwada. However, such diversity of species within this limited framework shows the importance of these animals in the Megalithic culture and suggests that subsistence at Khairwada was based on a combination of stock-raising, hunting and possibly farming (Thomas in press).

Table 1: The frequency percentage of animals at the various Megalithic habitation sites in Maharashtra

			Sites		
		BMR	KRD	NKD	TKP
Bos indicus	(Cattle)	46.58	53.90	70.70	63.88
Bubalus bubalis	(Buffalo)	—	05.67	02.80	06.98
Capra/Ovis	(Sheep/Goat)	11.87	13.47	09.80	18.06
Sus domesticus	(Domestic Pig)	13.87	00.71	04.40	06.23
Equus caballus	(Horse)	01.08	—	04.10	00.34
Canis familiaris	(Dog)	—	—	02.50	—
Bos gaurus	(Gaur)	—	—	00.60	—
Capra/Ovis	? (Wild Sheep/Goat)	—	—	00.30	—
Cervus unicolor	(Sambar)	00.18	02.84	06.60	+
Axis axis	(Chital)	—	03.55		—
Muntiacus muntjak	(Barking Deer)	01.98	—	—	—
Tragulus memina	(Mouse-deer)	—	02.84	—	—
Tetracerus quadricornis	(Chowsingha)	04.31	10.64	—	—
Lepus nigricollis	(Hare)	00.36	—	00.90	—
Birds		19.97	04.96	—	+
Turtle/Tortoise		00.18	01.42	—	—
Monitor lizard		00.18	—	—	—
Crab		00.18	—	—	—
Lamellidens marginalis		+	+	+	+
Corbicula sp.		+	+	+	—
Digoniostoma pulchella		+	—	+?	+
Melania striatella tuberculata		—	+	+?	—
Turbinella pyrum		—	+	—	—
Cyprae arabica		—	+	—	—

+ = Presence; — = Absence; BMR = Bhagimohari, KRD = Khairwada, NKD = Naikund, TKP = Tekalghat Khapa

Another major excavation was carried out at Naikund in Nagpur District. The habitation deposit had a thickness of about 1.5 m to 2.2 m. Twelve species of animals both wild and domestic, were identified (Table 1; Badam 1982). A number of bone tools were also collected. Wheat, black gram, lentil, pea, Indian jujube, etc. formed part of the diet of the people (Kajale 1982). The food economy was based on a combination of stock-raising, hunting and farming (Thomas, in press).

Excavations at Tekalghat Khapa also in Nagpur District yielded 11 species of animals including cattle, buffalo, sheep, goat, pig, horse, sambar, domestic fowl, rat, pond snail and fresh water mussel (Deo 1985). Cattle were the predominant species in the food economy of the people.

Discussion

Burial Sites

The faunal remains from the Megalithic burials, at all the excavated sites, show a uniform pattern of partial burials of the horse, consisting of the skull and the lower extremities of the limb bones. The one exception is the presence of *Bos indicus* in one of the graves at Naikund.

What must have happened to the rest of the body of the animal? Horse bones were found along with kitchen refuse at Naikund and Bhagimohari (Thomas, in press). Possibly after the sacrifice and subsequent offering to the dead person, the rest of the horse was consumed ceremoniously by the kin of the deceased (Thomas 1989). Animal sacrifices and food offerings have also been reported from a number of the preceding Chalcolithic and Neolithic cultures from all over India (Thomas 1984).

The Iron Age Megalithic settlements and burial sites in Maharashtra are found in isolation and not as a continuation of the Chalcolithic culture, whereas in south India the Megalithic cultures generally succeed the Chalcolithic and Neolithic cultures. However, the people of the Late Jorwe phase (1000-700 B.C.) at Inamgaon, a Chalcolithic settlement site in Pune District, may have had cultural contact with the Iron Age populations of this region consequent to which the horse was introduced into this cultural phase. Horse bones with cut marks and charring, found during the Late Jorwe phase, suggest that the horse was consumed here (Thomas 1988). The horse is also reported from the late phases of Neolithic and Chalcolithic cultures of India most of which, chronologically, correspond with the early Iron Age period. However, the identification of the horse and ass from different archaeological sites has to be carefully and cautiously used. There is always a problem of correct identification as three species of the same Genus, *Equus caballus* (horse), *Equus asinus* (ass), *Equus hemionus* (wild ass) and the half-ass (cross breeds between the horse and ass i.e., Mule and Henny), are present on the Subcontinent and from the fragmentary remains of bones and teeth it is difficult to distinguish among them unless the diagnostic characters are carefully studied.

The evidence from Megalithic burials suggests that both stallions and mares were sacrificed between the ages of 3.5 to 6 years. Probably well trained older horses were spared. Horse sacrifice may have been linked with the status or profession of the deceased. Partial burials of horses have been reported from Hungary (Bökönyi 1974) and from Dereivka in the Ukraine (Anthony and Brown 1989; Telegin 1973). In India, the horse was an important animal in the Iron Age and its presence would have enhanced the mobility of the people and rendered their defences more efficient.

Economy and Diet

The economy of these Iron Age people was based on a combination of stock breeding, farming, hunting and the exploitation of aquatic resources. The main occupation may have been cattle pastoralism. The importance of cattle is evident from the large number of cattle bones at all the settlement sites (Thomas 1991). The presence of cattle bones in a burial at Naikund in place of the horse illustrates the significance of cattle in the local Megalithic culture. Bird hunting was also a major activity especially at Bhagimohari. In some of the strata, bird bones outnumbered those of sheep, goat and pigs. Pigs were abundant in the sub-tropical forests of the Vidarbha region and were presumably hunted in large numbers by the Megalithic people. Aquatic resources were also an important source of food and though many of the sites have not yielded fish remains, this may have been because of the small-scale excavations and the limitations of the retrieval methods employed at these sites. The presence of marine shells used for making ornaments indicates cultural contacts with coastal traders.

Luckas, Burrow and Kennedy (in Deo 1985) who studied the human skeletal remains from some of these Megalithic sites state that the bowed femora and dental hypoplasia are due to dietary deficiency. They further state that the large size of the molars are indicative of a mixed economy or one that is more dependent on hunting and gathering rather than on agriculture. The massive pilastering of the linea aspera of the femora seen in the case of two male skeletons may have been due to horse riding. The concentration of sites in the hilly forested areas, the absence of well-made houses and storage jars, and the presence of the horse further indicate that the Iron Age people of Maharashtra had a fairly mobile lifestyle.

Acknowledgements

I am indebted to Ms. Kathleen Ryan of the University of Pennsylvania for comments on the manuscript.

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A Biocultural Study of Man in India

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Abstract

This paper presents the recent developments and research trends adopted in anthropology for the benefit of both scientists as well as laymen. It presents a general review of research work that has been undertaken by physical anthropologists over the last fifty years in a continuing attempt to understand the biological and cultural history of peoples in the context of the changing environment. No aspect of past behaviour, cultural or biological, can be studied in isolation. An interdisciplinary approach by archaeologists and physical anthropologists, reveals very interesting aspects of man's adaptability to various ecosystems.

Previous Research in Palaeoanthropology

Anthropology, the study of man, was established as a scientific discipline in the early 16th and 17th centuries. Physical anthropology, a sub-discipline of anthropology, in its early stages, was considered to be primarily a technique concerned with the study of mankind, its origins, evolution and place in the animal kingdom.

During the search for human ancestors, many fossil remains were discovered which led to the development of various schools of thought each trying to put forward its own hypothesis as to who our direct ancestors were. Mere analytical descriptions, classifications and metrical comparisons were not enough to understand the events and processes of human evolution. However, the development of new investigative tools and techniques within the last 2-3 decades, led to the accumulation of new information. New analytical methods, in turn, led to new areas of anatomical investigation being explored. It was at such a time that palaeoanthroplogy, the study of primate and human development, as an interdisciplinary science was born. Although, its roots go back to the mid- 19th century, when anatomists, medical doctors and natural historians, stimulated by the discoveries of 'Neanderthal Man' in 1856 and the publication of Darwin's '*Origin of Species by Means of Natural Selection*' in 1859, were first confronting the implication of extinct human types, it was in the early 1960s that studies of early humans began to focus on broader objectives and areas of inquiry. The science of paleoanthropology has been aptly summarized by G.E. Kennedy (1980: xiii), "Palaeoanthropology is, then, a search of the fossil record in all its material manifestations; its goal is the reconstruction of the environmental milieu in which the close and distant ancestors of *Homo sapiens* existed".

Palaeoanthropologists who studied the fossil record had done so with a view to ascertain and establish human antiquity and to trace evolutionary progress from the first divergence from the apes. In the process of collecting and classifying a large number of morphological data on extinct and extant populations, many new principles and techniques were developed to study human ancestry and distinguish between ethnic groups. These studies were carried out with the help of anthropometry, which has been defined as, "the conventional art of measuring the human body and its parts, and it includes the measurements that are taken on both skeletons and living human bodies" (Bhowmik 1988: 20). Earlier research on extant human groups merely classified them into groups of races depending on physical or phenotypic characteristics, such as skin colour, hair texture and various other facial features (Hooton 1956, Coon 1939). Such a system of racial classification only serves to identify populations that vary in some significant way. The usage of the term 'race' for social or economic discrimination has had appalling consequences, most notably the anti-Semitic feelings aroused before World War II. In order to establish an accurate meaning for the term race, a panel of social scientists met under the auspices of UNESCO in 1950. Statements arising out of this meeting were further corrected by a group of anthropologists and geneticists in 1951 (UNESCO

1952). The scientific world now accepts all groups of people which exist today as belonging to a single species. It is in the light of this knowledge that is essential to evaluate the phenomenon of race.

The mechanism of inheritance which has produced the essential unity of mankind also produces infinite variety, in the sense that no two individuals are ever alike. Race can only be a more or less temporary assemblage of genes and gene complexes, common to all, but exhibited in a particular population with differing degrees of frequency. The term 'race' can thus be read as a manifestation of the constant adjustment of humans to their environment. Environmental changes not only lead to changes in the individual which are manifested externally but populations themselves bring about certain changes by means of their own varied life styles. Such changes occur only when the environment favours the survival and reproduction of those populations having better genetic advantages over others. Evolution acts as a selective process. However, only when there is variation in the gene pool can evolution be selective towards improved adaptation or progression. The variation upon which such selection operates is the result of the genetic composition of a population. The gene pool of each population thus differs from that of another in its composition. Each such population may then be regarded as a race. Thus the term 'race' may be used only when one breeding population differs from the other in a significant number of genes. As long as races are simply partially isolated breeding populations whose members are mostly related by descent, gene flow will continue to modify such populations (Boyd 1950). But in case of migration and outbreeding, if isolation is breached, can clear-cut boundaries for particular populations be made? Certainly, the physical characteristics they bear are similar to each other but they do not share the same genetic makeup. Hence, if one attempts to categorize populations into races, such categorization could become highly complex leading to overlapping. Races and similar groups are, however, not to be viewed as isolated groups of people, each of which may be distinguished from the others by averages of its phenotypic character. The populations that exist today within the human species have not, in most cases, been isolated long enough to develop highly distinctive hereditary characteristics. All of them have interbred to a greater or lesser degree, so that it is possible that there are a few genes that are not distributed, though in varying frequencies, throughout the whole of mankind. These particular groupings are then distinguished from the others on the basis of intermarriage. A grouping of this kind is termed as a 'Mendelian Population' in biology (Boyd 1950). If we are to scientifically study the diversities among human beings, then the term 'race' should not be given importance. Consequently, if attempts are made to classify human groups, living or extinct, such a classification will only have theoretical utility. In such endeavours, no racial classification should be made solely on the basis of a single trait, and the structurally variant characteristics of a group should be observed on a large sampling of the known sex-age group of the population concerned.

Earlier, the application of anthropometric procedures, i.e., accurate measurements and morphological observations of the human body laid emphasis on the quantitative descriptions of ape-human differences. The break from the traditional method of classifying groups of people into 'races' based on the earlier criteria of phenotypic traits together with the realization of the fallacy of ethnocentric thinking which had fostered the idea of genocide during the Second World War, led many anthropologists to seek explanations as to how populations evolved the various morphological characteristics that distinguished them from each other (Kennedy 1976) . The development of new instruments coupled with the objective scientific study of human groups, made anthropologists aware of the need to establish uniform standards of anthropometric procedures. Several attempts were made in this direction during the late 19th and early 20th century (Singh and Bhasin 1968). These new objectives provided further insights into the problem of our evolution. They realized that biological histories could be reconstructed partially with the help of prehistoric skeletal material, that the earlier classifications were inadequate and that the variations produced in the population were a highly complex process to be investigated (Kennedy 1976).

Attempts to distinguish races among prehistoric populations have a limited scope, for the archaeological skeletal evidence is mostly in the form of dry bones, leaving no soft markers for comparison. Moreover, extinct populations are seldom represented by large samples and are often recovered in a fragmentary state, thus making comparisons more complicated. Considering these limitations, any statement on the phenotypic affinities of an archaeological population will not have much value and should be accepted with caution. If certain differences in the skeletal record exist, and if these do not corresspond with the living population, then they are attributed either to invasions or migrations (Gupta *et al.* 1962). However, this is not an explanation for the presence of phenotypic differences in a population. Besides factors like migrations and invasions, others such as natural selection, mutation or genetic drift may also be taken into account. All these factors act on particular kinds of human groups. Thus, one must exercise caution in interpreting the archaeological record. A mere skull or a bone fragment is not sufficient to classify the population of a site as belonging to a particular race or group, but such fragments are important in the study of other aspects of past lifeways.

The Fossil Record of Human Ancestors

Setting aside the controversies, it is generally accepted by palaeoanthropologists that the earliest human ancestors can be traced to the ape-like primates that flourished during the Miocene and early Pliocene, i.e. roughly between 24-12 mya. To this time span have been assigned the species of the genus *Pronconsul, Dryopithecus* and *Sivapithecus*. Some palaeoanthropologists are of the view that the early hominoids (Super Family Hominoidea) diverged from the great African apes — the chimpanzee and the gorilla — whereas some opine that the hominoids diverged from the great Asian ape, the orang-utan. Based on comparisons of humans and apes, Darwin and others had postulated that man originated from Africa, which was later supported by fossil remains of the early Miocene hominoids and Plio-Pleistocene hominoids from Africa, but the discovery of *Homo erectus* from Java and China, and *Ramapithecus* from the Sivalik hills of the India was a blow to this hypothesis (Sankhyan 1988a). Now, various hypotheses are being put forward regarding the Asian origins of early hominoids. It is a well-known fact that the genus *Proconsul* precedes *Dryopithecus* and *Sivapithecus* on the basis of cranio-facial morphology. Therefore, the conclusion drawn is that either or both *Dryopithecus* and *Sivapithecus* qualify as the direct ancestors of the extant great apes and hominoids. Both *Dryopithecus* and *Sivapithecus* belong to more or less the same temporal span, but geographically *Dryopithecus* is better suited to the ancestry of African great apes and *Sivapithecus* to the Asian orang-utan and to the Plio-Pleistocene hominoids. These Miocene hominoids, having a wide temporal range (around 15 million years), lived in different climatic and geographical settings. The Miocene period witnessed the origin of separate populations stemming from a single hominoid genus. The evolution of the genus Homo is believed to have taken place over at least half a million years -a time when the first Alpine glaciation was occurring in the North. Human beings evolved during the Pleistocene, which extended from about 2 million to about 10 thousand years before the present.

Africa has provided us with the earliest hominid skeletal remains. The term 'hominid' is a colloquial version of the technical term for the Family Hominidae. The oldest of the human fossil relatives — the Australopithecines — are found in the Pliocene, some 3 to 4 million years ago, and flourished for a span of about 2 to 3 million years. The species *Australopithecus africanus*, has been given the names — "ape-men", "man-ape", "near-men" or even "primitive men". The bones of these species have been found in Africa at Transvaal, Olduvai Gorge, East and West Turkana, the Omo River Valley and Laetoli. Although, the Australopithecines were man-like apes or even ape-like men, the hypotheses concerning their ancestry to man is controversial. While they had brains no larger than those of apes, their pelvis (hip bone) was shaped more or less like that of modern individuals so that they probably stood erect but need not have been efficient walkers. As bipeds who were unable to defend themselves with their teeth and who could not flee from their quadrupedal predators, they were able to wield implements in self-defence as their hands were now free from locomotor activities. Bipedalism, may thus be attributed to culture in the sense that it lead to the anatomical changes referred to above. Whether or not these hominids were our direct ancestors, the very fact that they were able to stand erect and walk on their feet suggests that they fall within the phylogenetic line of the human evolutionary tree.

Three other important changes took place before hominids attained the status '*Homo*'. These were:

1. the increasing usefulness or specialization of the thumb and the hand;
2. the use of tools; and
3. the increasing size and development of the brain.

The co-occurrence of these probably led to the evolution of a more advanced species. This group of hominids is said to include all those who depend for their survival on learned behaviour and tradition passed on from one generation to the next. The presence of tools indicates the existence of culture. However, with regard to the biological capacity of the earliest hominids, more than a million years prior to the first evidence of stone tools, we have to make our judgement purely on the basis of anatomy.

The hominid *Pithecanthropus*, (now *Homo erectus*), is said to have lived half a million years ago, towards the end of the second Alpine glaciation. The first specimen of this hominid was discovered at Java, and hence is also referred to as Java man, who had attained a perfectly upright posture but did not seem to hold his head very erect. This 1.65 m tall hominid had a brain size approximately two-thirds that of modern man. This specimen had a large jaw, teeth and enormous eye-brow ridges. The other hominid, *Sinanthropus*, known as Peking man, was not quite as tall as Java man but stood straighter. The skull looked very much like that of the skull of Java man but contained more room for a larger brain. Peking man lived in a cave, made tools, cracked animal bones for marrow and used fire (Wolpoff 1980). This tool-making tradition began during the Middle Pleistocene when it may be assumed that these hominids practised hunting-gathering. The change to a food producing way of life did not begin until after the end of the Pleistocene. Peking man dates from as early as the inter-glacial period following the second Alpine glaciation, close to around 350,000 years ago. These are the first fossils to be given the status of Homo (Wolpoff 1980).

Neanderthal man, who was discovered in 1856 had a large bony head which could accommodate a larger brain. There are at least a dozen good examples of the Neanderthal species in Europe and they date to the earlier part of the last major glaciation (85,000 to 40,000 years ago). It was during this period (Upper Pleistocene), that major evolutionary changes seem to have occurred, as is evident from the fossil record. These changes were not only anatomically represented but were also evident in the cultural development that proceeded at a rapid pace. The rise of increasingly complex patterns of social organization and subsistence marked this period of man's evolution, enabling the exploitation of open grasslands for the purpose of food production. The majority of the sites of this period are located in Europe and West Asia and are well documented. Recent discoveries in Africa and China have pushed back the ancestry of *Homo erectus* to about 2 million years and 1 million years respectively (Maier and Nkini 1985; Rukang 1985).

The Fossil Record in India

The fossil record of the evolution of *Homo sapiens* in the Indian subcontinent is rather scanty. The earliest fossil found was that of the Genus *Ramapithecus* in the Sivaliks, and is dated to around 12 to 8 million years B.P. (this genus is now linked with the earlier taxon *Sivapithecus*, but controversies exist about its phyletic relations with the extant great apes and the Plio-Pleistocene hominoids) (Sankhyan 1988b). This Genus is represented by well preserved dental remains as well as a few facial and post-cranial bones found in the Potwar region.

The other important fossil is the controversial 'Narmada skull' found at Hathnora, on the bank of the river Narmada, 40 km northeast of Hoshangabad in Madhya Pradesh (Sonakia 1985a). This fossil was recovered from the Pleistocene alluvium in association with stone artefacts like heavy handaxes, cleavers, and scrapers said to be of pre-Soan type. The 'Narmada skull' is represented by the completely preserved right half of the skull cap with part of the left parietal attached. No facial bones have been recovered. The individual concerned appears to have been fairly old, robust with an erect posture and a fairly well developed brain. The general robusticity, the thick and projecting supra-orbital torus and its occipital protuberance are akin to the classic Neanderthal group, while slight sagittal keeling, widely placed mastoids and a smaller cranial capacity (1200 cc) bring it closer to the *Homo erectus* of Java, China, Tanzania and Kenya, although it is considered to be closest to Java man (Sonakia 1985b). There are others, however, who argue about it being 'Archaic *Homo sapiens*' on the basis of the cultural material found associated with it (Badam *et al.* 1986; Badam 1989). This hypothesis has been tested through comparisons with both metric and morphological traits of *Homo erectus* which showed that only 43% of these traits are present in the Narmada specimen. Further investigations and comparisons of each morphological trait with those of Middle and Late Pleistocene fossils from Africa, Europe and Asia, prove that the Narmada specimen is *Homo sapiens* and not 'evolved' *Homo erectus* or "archaic" *Homo sapiens*. Moreover, these terms no longer hold any taxonomic significance with the advent of newer trends in palaeoanthropology (Kennedy *et al.* 1991). The fossil gap between *Ramapithecus* and the 'Narmada skull' is, however, much too wide to give a continuous picture of the progress of the evolution of Homo sapiens in India with respect to its position in the world-wide scheme of evolution.

The Prehistoric Skeletal Record in India

Pleistocene fossils are unknown in South Asia. Exceptions are the Narmada skull and some human remains in the lowermost level at Batadomba lena, Sri Lanka (radiocarbon dated to around 28,500 B.P.) (Kennedy *et al.* 1986a). The earliest reported discovery of human skeletons in India is associated with the Mesolithic cultural phase at Morahana Pahar, Uttar Pradesh (Kennedy 1980). The Indian Mesolithic (8,000 to 5,000 B.C.) is characterised by the presence of microlithic tools of geometrical and non-geometrical shapes, and appears to be a period of intense population expansion and cultural innovation as indicated by the varied environmental settings that are documented in the archaeological record. The earliest Mesolithic skeletons in India are known from Sarai Nahar Rai, in the Ganga plains dating to 8,050±110 years B.C. This radiocarbon date is considered unreliable as it was obtained on the inorganic matrix of unburnt and highly calcified bone (Kennedy *et al.* 1986b). The other Mesolithic skeletal specimens found at Bagor, Lekhahia ki Pahari and Langhnaj are separated from the Ganga specimens by a temporal gap of a few millennia.

The Mesolithic sites in Sri Lanka, namely, Batadomba lena and Beli lena have been dated by the radiocarbon method to c. 14,000 years B.C. and c. 10,500 years B.C. respectively, providing palaeoanthropologists with the earliest fossils of *Homo sapiens sapiens* recovered so far from South Asia (Kennedy *et al.* 1986a). The Sarai Nahar Rai skeletons, which have been restudied in the light of the present trends in palaeoanthropology, have yielded important information relating to the course of human biological evolution in the Indian subcontinent. These Mesolithic skeletons are characterized by large and muscular robust skulls, tall stature and large teeth, slowly leading to reduction in body size in later Mesolithic times. The explanation offered for these differences in populations belonging to different time periods, is the ever present evolutionary mechanism of adaptation. The successful biological adaptation of the Mesolithic populations and the exploitation of new environmental settings, which has been well documented by the archaeological record, attests to the development of fairly sophisticated socio-economic strategies well before the advent of the food-producing communities (Kennedy *et al.* 1986b). These trends towards decreased cranial robusticity, reduction of body size and tooth size to skeletal gracility have been observed in the course of hominid evolution over a period of 10,000 years (Wolpoff 1980). These changes are due to factors like natural selection which makes the human body more adaptive to village and urban lifeways, which, in turn, involve increased carbohydrate intake and a decrease in protein intake. Tooth size reduction is also indicative of dietary change. The progress of dental reduction over time has been closely linked to the rate of technological development and increased efficiency of food-producing techniques. The people with the smallest teeth in the world are said to be those whose remote ancestors first developed a complex technology. According to observations, the smallest teeth appear among the northern and the northwestern populations of the Subcontinent, whereas large teeth survive in peninsular India and Sri Lanka (Kennedy 1984b). For example, the Sarai Nahar Rai skeletons exhibit large teeth which are said to be adaptive for a pre-agricultural, pre-pastoral society, whereas the subsequent Neolithic skeletons of the same area exhibit smaller dentition which is suited to the diet of an agricultural society. The pattern of dental variation among living populations today is closely correlated to differing levels of technological development, subsistence patterns and methods of food preparation.

Skeletal material in India has also been recovered from other cultural phases like the Harappan, Neolithic, Chalcolithic, and Iron Age. Of these the Harappan skeletal material is often regarded as of paramount importance as it has an extensive and well documented skeletal series. The Harappan civilization began towards the end of the 3rd millennium B.C. in the Indus Basin and flourished over a wide geographical area extending from Baluchistan in the west into the interfluve on the east and from the eastern foot of the Sulaiman Mountain Range in the north to the Tapi estuary in the south. The Harappans had well planned cities with public buildings, fortification walls, granaries and a standardized system of weights and measures. All these reflect a highly developed socio-political organization and an economy which could support a large population.

In Pakistan, three major Harappan skeletal assemblages have been found at Cemetery R-37, Cemetery H and the Mound Area. By comparing variations at the population level, it has been shown that despite the human skeletal material coming from three different deposits, the bones belong to a single morphologically homogenous series (Kennedy 1982; Dutta 1983), in contrast to their previous classification into morphological "races" and "sub-races" (Gupta *et al.* 1962). On the basis of certain metric and statistical observations, the ancient Harappan population shows close affinity with that of Tepe Hissar (Iran) and Sakkara (Egypt) (Dutta 1984). However, certain differences do exist, and these differences though small, are of immense importance, specially when trying to place the Harappan population in the biological taxon. These differences would suggest that the Harappans occupied a distinctly unique status, but does not necessarily imply that the ancient Harappan population came from elsewhere. The human skeletal remains from Mehrgarh and the ceramics of non-Harappan character, like those found at Kot Diji which records a pre-Harappan phase, make it clear that the Indus valley was inhabited by pre-Harappan communities before the advent of the Harappans. It would seem reasonable to conclude that there might have been biological links and genetic continuity between the pre-Harappans and the Harappans, considering the uniqueness of the Harappan physique with regard to the reference population groups and the cultural sequence in this region.

Contemporary with the Harappan Civilization in India, is the Neolithic phase which covers a wide time span from 3,000 to 1,000 B.C., and a wide area extending from Burzahom (Kashmir) in the north, to Assam and other sites in the northeast, to sites in the south like Kodekal, Utnur, Nagarjunkonda, Palavoy (Andhra Pradesh); Tekkalakota, T. Narasipur (Karnataka); and Paiyampalli (Tamil Nadu). In India, Neolithic cultures are also associated with the contemporary Chalcolithic cultures, with the exception of Burzahom which has no parallel. This site is devoid of a stone blade industry which otherwise is characteristic of the other Neolithic sites in India. The cultural material from Burzahom consists of stone axes, ring stones, a single copper arrowhead, and a range of bone points, which indicate that the economy was primarily based on hunting and gathering. There is no evidence of agriculture or domestication. The cultural material of Burzahom is often associated with the Neolithic cultures of north and northwest China and Central Asia. However, the human skeletal remains show biological affinity with the mature Harappan skulls from Cemetery R-37. The morphological features that show similarities are the long and narrow heads (dolichocephalic), low receding forehead, and a sturdy physique with tall to medium stature. These features seem to suggest some ethnic continuity between the Harappan and the Burzahom series in spite of cultural differences (Basu and Pal 1980).

The South Indian Neolithic, extends from around 2,500 B.C. to 1,000 B.C. The inhabitants of this culture occupied areas in and around the hills and rocks overlooking the plains. However, not many skeletal remains are available from the Deccan and Southern Neolithic except at Tekkalakota, Piklihal, T. Narasipur and some of the Neolithic-Chalcolithic sites like Nevasa, Chandoli and Ramapuram. Regarding the origin of the Southern Neolithic it has been postulated that West Asia was the centre from where it originated (Jain 1979). The metrical and morphological comparisons of the skeletal material from Tekkalakota with that of Mohenjodaro, Cemetery R-37, Bellan Bandi Palassa (Sri Lanka), Nal, Sialkot and Lothal indicate a certain similarity . However, when the Tekkalakota specimens are compared with those of Neolithic Burzahom, the latter show closer affinity to the mature Harappans than to the Tekkalakota specimens (Basu and Pal 1980). These variations could be attributed to regional differences and nothing more can be said at this stage as the sample size is small and so far only the Tekkalakota and Piklihal specimens have been compared with those from Harappan sites. The Southern Neolithic specimens also show closer affinity with the Neolithic-Chalcolithic specimens at Nevasa and Chandoli which are their contemporaries.

The Chalcolithic cultures of Maharashtra, viz. the

Malwa, the Early Jorwe, and the Late Jorwe, all of which flourished during the second millennium B.C. marked the beginning of sedentary life in this region. Though they were all rural cultures which did not develop into urban centers like those of Harappa and Mohenjo-daro, the Chalcolithic sites have yielded evidence of the existence of a class structure and a well organized social life. This culture is characterized by a wheel-made Black-on-Red painted pottery. Siliceous stones such as chalcedony and chert were the raw materials for the well developed blade/flake industry. Copper was known to the Chalcolithic people, but was used on a restricted scale as it was scarce. The people subsisted on farming, stock raising, hunting and fishing. They lived mainly in either rectangular or round-shaped huts though there is also evidence for pit dwellings (Dhavalikar 1988).

The first Chalcolithic settlement was discovered near Nasik in 1950 and since then over 200 sites of this culture have been discovered in and around Maharashtra. The largest concentration occurs on the Deccan Plateau which is characterized by black cotton soil and scanty rainfall. Over the last few decades several Chalcolithic sites have been subjected to large-scale archaeological excavations. Almost every excavated Chalcolithic site has yielded human burials. However, many of these burials are symbolic, and osseous remains from many more burials have not survived. Nevertheless, some of these sites have yielded excellently preserved human skeletons. Comparative and interpretive studies carried out on these skeletal collections have revealed many important features pertaining to the biological patterning and lifeways of these populations. Comparative homogeneity occurs in the cranial and facial features of the Chalcolithic populations of the Deccan plateau, the most obvious reason being the close geographical, temporal and cultural proximity among these sites (Lukacs and Walimbe 1984).

Comparative studies carried out on the skeletal material representing the Mesolithic and Chalcolithic periods have brought to light certain interesting evidence. For example, changes noticed in the cranio-facial morphology attributed to the changes brought about with the shift to incipient agriculture and the subsequent intensification of agriculture are, a progressive decrease in robusticity, a rotation of the facial region to a position more inferior to the cranium, and a relative increase in cranial height and decrease in cranial length (Fig. 1). These cranial and post-cranial morphological changes can be attributed to differential functional demands due to shifts in the economies and associated lifeways. The earlier hunter-gatherer settlements were small but the introduction of agriculture altered the settlement pattern. The villages became larger and were permanently occupied. These sedentary settlements are supposed to have led to higher birth rates (Cohen 1977). The end of nomadism meant less stress during pregnancy and better post-natal adjustments. This led to a sudden increase in population which is evidenced in a large number of Early and Late Jorwe settlements as compared to the settlements in the Malwa period. However, such an analogy needs to be made with caution as preservation of sites, exploration and excavation techniques solely depend on the methods and research objectives of archaeologists. Secondly, the diet in the hunter-gathering stage was rich in minerals, proteins, vitamins and trace nutrients but relatively low in starch. Though the intensified use of vegetables and cereals as food sources assured greater dietary stability, it led to a less nutritive diet. Agricultural practices probably led to an increase in the carrying capacity of the land, which was necessary to feed the growing population. In spite of the well-planned irrigation system as seen at Inamgaon, inadequate technology, e.g., the absence of an iron plough, probably could not improve food production beyond a certain level, thus resulting in the ineffective cultivation of the black cotton soil. The change in settlement pattern, the resultant increase in population size and inadequate food supply led to an increase in infectious and degenerative diseases in the later phases of the Chalcolithic culture. Decreased skeletal robusticity, reduced sexual dimorphism, very high infant/child mortality, retarded skeletal growth and a higher rate of non-specific dental and skeletal infections indicate the presence of stress (Lukacs and Walimbe 1984; Walimbe and Lukacs 1992).

The drastic change in the climate around c. 1,000 B.C., leading to increasing aridity, is also cited as an alternative explanation for the decline in health during the later Chalcolithic period (Dhavalikar 1988). Such climatic changes, coupled with increasing population pressure and high infection rates were probably responsible for the decline of the culture. In later phases the stressful conditions forced these early farming communities to gradually resort to sheep/goat pastoralism leading to a semi-nomadic existence.

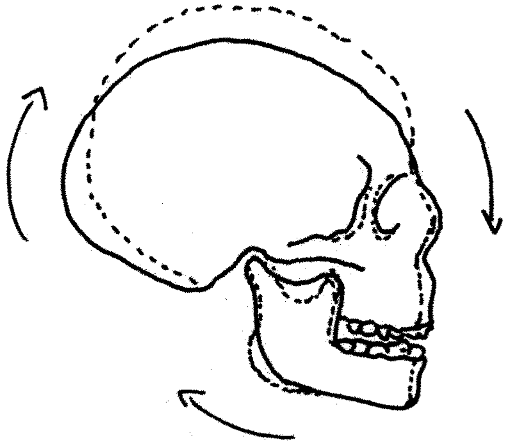

Fig. 1: Cranial changes during the transition from the pre-agricultural (__________) to the agricultural (- - - - - - - - -) stage

The Chalcolithic culture, unlike the Harappan, died off as a village culture.

Around 1800 B.C., the Indus Valley Civilization in northwest India had attained its zenith, while Lothal and other bronze-using communities to the south and east of the Indus Valley were entering a Late Harappan cultural phase. By this date, western Asia had developed a procedure for smelting iron, and although it did not enter the full Iron Age until c. 1,000 B.C., iron began to replace bronze at Sialk in Iran a little before this time, reaching Baluchistan only after 1,000 B.C. In the meanwhile between 1,050 B.C. and 450 B.C. iron had diffused in association with the Painted Grey ware ceramic over parts of Sind and Punjab and northern Rajasthan, and eastwards to the Ganges-Jamuna Doab, closely corresponding to the pattern of the spread of the Late Harappan cultures of North India (Agarwal 1982).

Of the skeletal material from the Megalithic sites, not much has been forthcoming, due to the relatively small-sized collection and, as often, only crania are represented. It has been stated that the Megalithic population belonged to a single racial stock. Such assumptions were based on metrical data. Where variation was evident, it was put down to 'divergent ethnic characters' or the interaction of two races. However, this sort of terminology is now considered unscientific. A re-examination of the skeletal material has led to the conclusion that variability of physical characteristics is a conspicuous feature of the biological nature of the Megalithic population (Kennedy 1975). It is an established fact that since the terminal Pleistocene hominids have undegone an evolutionary process whereby the cranial vault increased in breadth in relation to its length, i.e. populations which were dolichocranic (long-headed) over a period of time gradually developed to brachycrany (broad-headed), with some people retaining the dolichocranic feature. These changes in head form have been attributed to non-genetic pressures such as infant cradling practices, nutrition, pathological factors, and other effects of the cultural and non-cultural environment. With regard to the Megalithic population in India, specimens from Aditanallur, Ruamgarh, Sanur, Ranchi, Savandurga and Pomparippu are represented by the dolichocranic head form whereas specimens from Brahmagiri, Nagarjunakonda, Mysore and Yelleswaram represent the brachycranic head form. These two categories have often led writers to assume that the specimens from the latter group of sites belong to an 'intruder population' replacing the earlier dolichocranic Neolithic inhabitants of the area. With a history of brachycrany observed in different cultures, and recognizable from widely separated geographical regions, it would seem inconceivable to think that a sudden catastrophic event like the invasion of new people into the Indian subcontinent could replace the existing population (Kennedy 1975). The southward diffusion of iron was relatively slow, spreading from the northwestern sector of the Indian subcontinent to Maharashtra and to the south. Furthermore the existence of cairn burials which typify the Megalithic culture in North India (and also among some of the living tribal populations) cast doubt on the 'sudden invasion' of new people. From the anthropological studies thus far carried out, it can safely be said that the Megalithic population does not represent a single racial element but was phenotypically variable with respect to a broad spectrum of physical characteristics. The present-day people of peninsular India are thus direct descendents of the Megalithic population, as represented by the broad range of phenotypic characteristics.

Present Trends in Biocultural Anthropology

Previously, palaeoanthropological research was focused only on complete adult crania, the primary objective of such studies being only to draw conclusions regarding the possible ethnic identity of the population. Infant and sub-adult bones were usually discarded, so also were the post-cranial bones, as these elements do not possess racially diagnostic features. But if we are to provide answers as to how ancient populations lived, how they coped with the surrounding environment with the technology they had, then all these fragmentary bones, which may seem of no value to the archaeologists, must also be analyzed. If such a palaeodemographic approach is desired, then every piece of preserved human bone, cranial or post-cranial, fragmentary or complete, needs to be scrutinized, since it can yield information on the health, occupation, age and sex of the deceased. A synthesis of both archaeological and anthropological data is necessary to understand the process of cultural evolution and its impact on human life and vice-versa.

In India, studies of palaeodemographic factors affecting population size, density, mortality, fertility and life expectancy and based on the skeletal record have been relatively few, but have increased since the 1960's (Kennedy 1984b). The use and interpretation of multivariate analysis and other statistical methods help in answering more precisely the questions of biological distances between different prehistoric series and the present day population of the Subcontinent. The evidence of ancient populations over a wide geographical area and temporal span is well documented from Mesolithic times (hunter-gatherer stage) right up to the Megalithic and Historical periods. It has been suggested (Fairservis 1971; Cohen 1977) that the hunting-gathering way of life brought with it a dramatically low density dispersal leading to the exploitation of new areas in a variety of ecological settings, along with advances in technology to cope with the new environment. Further evidence for the stability of the food resource base for many hunting-gathering communities comes from the skeletal record of relatively high ages at the time of death as compared to the lower ages at the time of death seen in the later farming-herding communities. A combination of factors may be responsible for this. The high incidence of pathologies noticed in the later farming-herding communities in the skeletal record in India may be due to a nutritionally poor diet which consisted mostly of cereals and/or root crops. Moreover, hunter-gatherers probably ate both meat and forest products whereas the agriculturists had a narrow choice of food with nothing to supplement their diet if and when their crops failed. For example, the causes of nutritional stress (Lukacs *et al.* 1986) in the Deccan Chalcolithic populations was probably the result of a deficiency of nutrients in the staple crops, periodic famines evidenced by archaeological data, food shortages and high infection rates due to population growth.

Nutrition and disease are integrally and synergistically related to one another. Malnutrition can lower an individual's resistance to disease, so also, disease can cause malnutrition by increasing the body's need for certain nutrients. Another factor is mobility. Hunter-gatherers moved about more often and hence could hardly be prone to epidemics (Scrimshaw *et al.* 1968). However, movement into new areas could prove disastrous due to contact with pathogens in the new area. In a more settled lifestyle the incidence of infection may be greater and if resistance is low the chances of survival are not high. Lesions appear on the skeleton as a result of a particular disease and/or deficiency in the diet. Hence these pathological markers are used as indicators of physiological stress (Buikstra and Cook 1980; Cohen and Armelagos 1984; Huss-Ashmore *et al.* 1982; Kennedy 1984b). A primary goal of palaeopathology is to 'read' these indicators of physiological stress. Two common examples of such periodic stress indicators are Harris lines, i.e. disruption in linear bone growth and enamel hypoplasia, i.e. disruption in tooth enamel matrix formation (Fig. 2). Some diseases leave more specific marks of stress on bones and teeth. Infectious diseases, nutritional deficiencies, traumatic and degenerative lesions are classified in this category. Porotic hyperostosis and cribra orbitalia (Vitamin C deficiency) as well as iron deficiency anemia, indicate nutritional stress (Fig. 3). Specific infectious diseases, such as treponema (yaws/syphilis), tuberculosis and leprosy, or non-specific infectious lesions like periosteal reactions, osteomyelitis (inflammation of bone), all of which leave telltale signs on bones, can be diagnosed. Traumatic lesions, such as fractures, dislocations, artificially induced deformities are caused by physical force or by contact with blunt or sharp objects. Degenerative conditions, like osteoarthritis (joint disease), vertebral osteophytosis (vertebral lipping) are

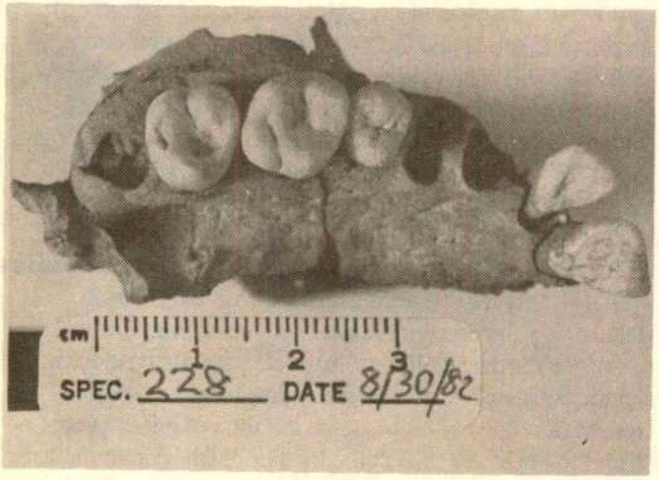

Fig. 2: Enamel hypoplasia. Note congenital circular hypoplastic depression on molar tooth

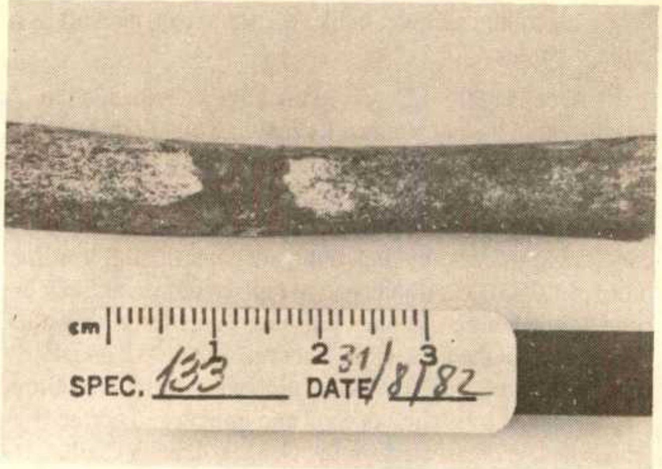

Fig. 3: Perostitis

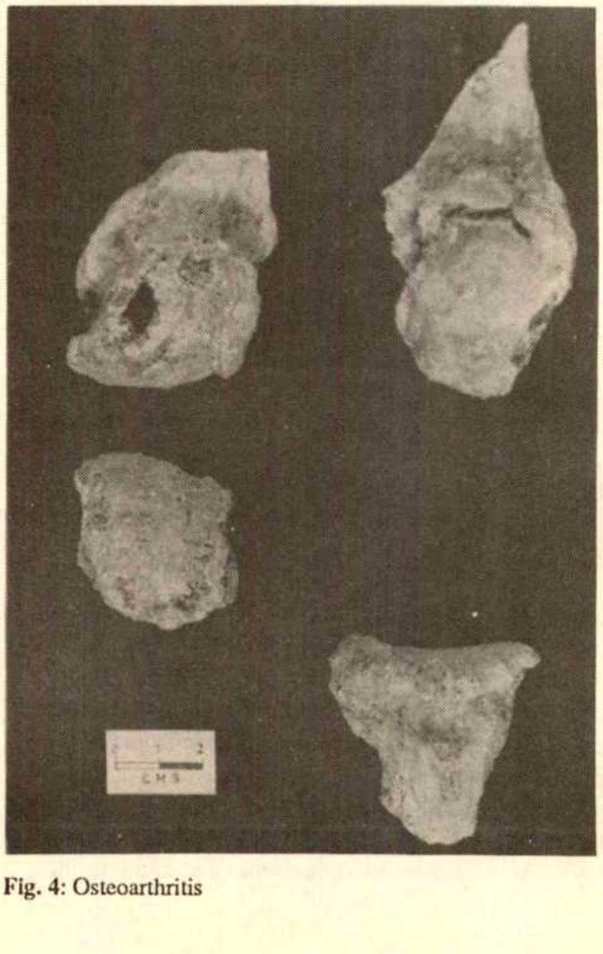

Fig. 4: Osteoarthritis

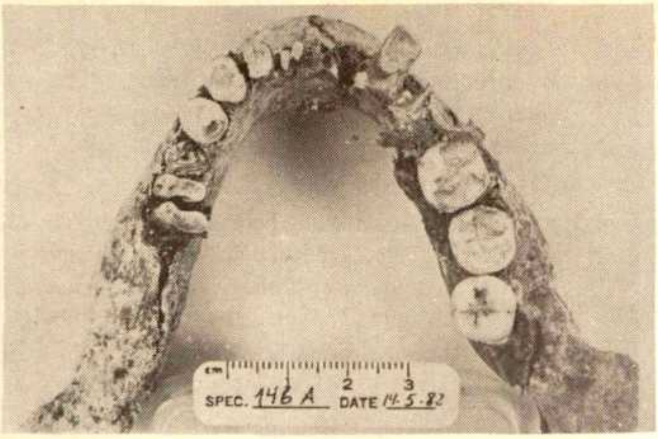

Fig. 5: Dental disorders. Note attrition, alveolar resorption, tartar accumulation and ante-mortem tooth loss

common in old individuals (Fig. 4). Dental disorders like caries, attrition, alveolar resorption (abscess in jaw bone), tartar accumulation and premature tooth loss, all reflect dietary habits (Fig. 5). Thus the skeletal record that exhibits such pathological changes gives us a lucid picture of the population's behaviour — their subsistence economy, structure of settlements, warfare, division of labour, social class structure and even trade networks, etc. Although, the etiology of a lesion may be multiple, and its exact cause unknown, it is possible to reconstruct the history of stress for a given population by taking into account the various other lesions that may have affected the rest of the population. The study of palaeopathology has developed into a specialized branch in anthropology. It has now come to be associated with the study of skeletal biology, whose emphasis is on the prehistoric population of the Pleistocene and Holocene period. Further, the analysis of bones and teeth,(the latter being the most reliable indicator of changes that have taken place in the ancient population and often the only indication of their presence) helps determine proportions of trace elements such as strontium (Sr), zinc (Zn), magnesium (Mg), calcium (Ca) and even carbon isotopes (^{13}C) which act as signatures of the food eaten (Price 1989). Changes in adult stature or other skeletal dimensions, (e.g. the Mesolithic specimens of Mahadaha and Sarai Nahar Rai as compared with the Deccan Chalcolithic population: Lukacs, personal communication), decrease in the size of teeth, (e.g. the people of the North have smaller teeth than those in the South as it is assumed that the former developed technologically much earlier than the latter), and delayed growth in children are used as indicators of the nutritional status of that population.

Conclusion

The Indian skeletal record, covering a vast time span, can be used to help biologists as well as archaeologists, to understand the interaction between ancient populations and their habitat and the change in their life style from hunting-gathering to a settled way of life. The skeletal record which exhibits bone disorders and a combination of other factors may provide the answers required by archaeologists. Just as pottery or other tools act as indicators of man's behaviour, so also does the skeletal record. A good database of archaeological human skeletal material and epidemiological models based on living populations is the prerequisite for research on 'skeletal biology'. In order to derive the maximum benefit from such studies, the osseous remains should be collected with great care and every single aspect recorded on the site immediately. Not only should adult crania along with the post-cranial bones be recorded but every sub-adult or infant bone, fragmentary or complete, should be considered, as the bones of children are often indicative of their state of health at the time of death, and can be of great potential anthropological value.

This paper has attempted to illustrate the research potential of physical anthropological data for the elucidation of the theories of human evolution and adaptation. The analysis of osseous remains from archaeological sites should no longer be relegated to being an appendix in archaeological reports, but should form part of an interdisciplinary approach to a study of the past for a better understanding of the biocultural adaptation of a population to its habitat.

The study of palaeoanthropology has come a long way from the simple earlier classification of the fossils of 'ancient man' and their grouping into 'ethnic classes', to the present study of the skeletal record as an entity in itself. This gives us a wider scope for providing answers regarding the continuous biocultural adaptation of ancient populations. How wrong we are in saying, 'Dead men tell no tales!'

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The Oman Peninsula and the Indus Civilization: A Reassessment

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Abstract

During the past twenty years, archaeological research in the Oman Peninsula has yielded an unique set of data concerning the relations between the Indus civilization and a neighbouring country across the sea. This paper is neither a fresh review of the evidence, nor does it intend to make definite statements on archaeological research still in progress. The author's aim is to start with a re-assesment of the earlier literature and move on to the contribution of new research, particularly the Ra's al-Junayz excavations in eastern Oman, in order to suggest some guidelines for constructing a general interpretative framework necessary for the understanding of a growing body of primary data.

Early Research Between the Indus Region and Mesopotamia

The presence of Harappan elements in the Gulf of Oman had been anticipated since the beginning of archaeological research in the area. As a matter of fact, one of the earliest excavations in Bahrain, that of the "royal mounds" at 'Ali, was the work of E.J.H. Mackay *en route* to his major project at Mohenjo-daro (Mackay *et al.* 1929). Relations between Mesopotamia and the recently discovered Indus civilization were already well-known as a result of preliminary studies by prominent specialists of the time, and through a handful of objects since widely commented upon, both by Western and Indian scholars in the perspective of trade between Mesopotamia and the Indus, as well as by the identification of the ancient lands of Dilmun, Magan and Meluhha. What was mainly expected in the Gulf were material traces of the maritime route of the "Boats of Meluhha", at least since the time, and possibly even earlier, that these boats were compelled, according to a famous text, to deliver their cargo on the piers of Akkad. These traces came in the form of chert cubic weights discovered at Qala'at al-Bahrain in late City I, layers 23-22, and City IIa, layers 21-19 (Bibby 1970 and 1986: 110). The fact that these weights were found near the seashore wall of the city, in a building therefore named "custom's house", along with the evidence of Gulf stamp seals, itself illustrates the general interpretative frame: the fact that Dilmun/Bahrain (where Mesopotamian barrel-shaped haematite weights had also been found), was a point of exchange between Mesopotamia and the Indus, where both the weight standards were in use. Among other items suggesting evidence of relations with the Indus were two statuettes of rams found at Umm as-Sujjur (During-Caspers 1979) similar to a well known group from Mohenjo-daro (Marshall 1931: 360 pl. C.9). A group of Red ware jars with black painted bands associated with early City II is also generally considered to be of a later Indus origin (Hojlund 1989: 49 and fig. 2). Recently, two Gulf stamp seals with the Harappan script have been published, one from early City II and another from an unknown context ((Brunswig *et al.* 1983: fig. 8a-b, fig. 9 respectively). Potts (1991: 159-168) provides a recent detailed discussion of this type of seal.

All these discoveries occurred in a rather late context, the earliest accepted date for the beginning of City II being 2100 B.C. An apparent contradiction with the main bulk of evidence in Mesopotamia centers on the Akkadian period. Though this can even be traced earlier[1], it does not seem to have worried archaeologists, as rather late dates for the Mature Harappan were commonly accepted twenty years ago. Presently, although a large number of radiocarbon dates (Shaffer and Lichenstein 1989), suggesting the beginning of the same period around 2550 B.C. is being advocated

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[1] Especially if one goes beyond very obviously Indus-related material (e.g. stamp seals with inscriptions or etched carnelian beads) and recognizes the fact that other items like long carnelian beads from the Royal Graves at Ur are obviously of Indian origin.

(Mughal 1990: 195-96; Possehl 1990: 275), this contradiction is much more puzzling. Of course our knowledge of the periods prior to 2100 B.C. in Bahrain is very limited, therefore a cautionary approach is necessary. The Indus radiocarbon-based chronology *cannot* be compared with the "historical chronology" used in Mesopotamia, which is clearly lower if one refers to the very few radiocarbon dates that are at hand (Nissen 1987 a and b). This discrepancy, although never discussed, already hinders, and will continue to do so, studies related to Mesopotamia and the Indus. This may be, for instance, the reason why the largest and most recent synthesis of Gulf archaeology contains no chronological chart of the Bronze Age (Potts 1991). This problem will certainly not be easily resolved, but this is not the place to discuss it.

Early Discoveries in Oman

Early work in Oman investigated relations with the Indo-Iranian borderlands and not with the Indus civilization itself. Connections with the "Kulli culture" were advocated for the material assemblage from Umm an-Nar, albeit on a rather weak argument — that of the presence of an elongated humped bull on a Black-on-Red hemispherical jar from cairn V (Thordvildsen 1964: 219, fig. 23), tentatively dated to the second quarter of the 3rd millennium B.C. (Cleuziou 1989a: 69). The object is, however, different in style and in fabric from the Kulli ceramics. Many other similarities with southeastern Iran have been proposed (During-Caspers 1970b: 231-44), the most obvious link being the presence of Black-on-Grey painted canister jars and of Incised Grey ware in contexts dated to the second half of the 3rd millennium. These were emphasized by de Cardi (1968), During-Caspers (1970a), Tosi (1974) and others. Recent studies have provided definite clues for the import of Black-on-Grey painted ware from eastern Iran or Baluchistan (Blackman *et al.* 1989; Méry 1991: 205-207) while the Incised Grey ware appears to have been partly imported and partly locally made (Méry 1991: 238-239). This absence of items clearly of Indus origin led even During-Caspers (1970b: 259) to consider the possibility that the Oman Peninsula may have been linked to the "Kulli culture area" as opposed to the Indus area, as previously suggested by Dales (1965: 272).

The seventies and early eighties witnessed increasing discoveries and everybody working in the Oman Peninsula added, sherd by sherd, new pieces of evidence for a growing list of material that would suggest direct relations with the Indus civilization, or at least would be more reasonably described as objects of Indian origin in Omani contexts. In 1975 Frifelt wrote about a small Black-on-Red painted bottle from tomb 1059 at Hili which according to her "may be influence from the Indus valley" (1975: 368 and fig. 15d). This object was dated to the very end of the 3rd millennium B.C. and the question of imitation or import remained open, although this class of pottery can now definitely be considered as imported (Méry 1991: 258). In the same paper, Frifelt also proposed an Indus origin for a faience segmented bead from a tomb dating to the 3rd millennium from the Wadi Suq valley (Frifelt 1975: 375 and fig. 19b).

Further discoveries at Hili 8 and Maysar allowed their authors to discuss Oman-Indus relations at the South Asian Archaeology Conferences at Berlin 1975 (Cleuziou 1981) and Cambridge 1981 (Weisgerber 1984). At these meetings, and in agreement with what was already known from the Bahrain area, it seemed that all Indus-related finds appeared in very late 3rd millennium or early 2nd millennium B.C. contexts. Several sherds of large Red ware jars with an inner black coating had been discovered in the period III layers at Hili 8, and this context is attributed to the Wadi Suq assemblage which was at that time considered to be characteristic of the early 2nd millennium in the Oman Peninsula. The ware being similar to the Indus types and markedly different from the local wares, was already considered an import (Cleuziou 1981: 291), an impressionistic statement now confirmed by archaeometrical studies (Méry 1991: 240-57). After the discovery of rimsherds (Cleuziou 1984: fig. 41 n° 4; Cleuziou and Tosi 1989: fig. 11 n° 1-2), such sherds appeared to belong to a well-known Mature Indus type (Dales and Kenoyer 1986: 83-84). Such types were not found in isolation. Among other evidences was a sherd of a dish-on-stand with concentric rows of "thumb-nail" impressions found in unit 67, period III (Dales and Kenoyer 1986: 291; Cleuziou and Tosi 1989: fig. 11 n° 5). It was made in the Orange Sandy ware typical of the 3rd millennium, local[2] "Umm an-Nar" pottery, and therefore said to be a local imitation. The same interpretation was accepted for a sherd displaying horizontal cord impressions[3]. Eventually, however, the frequent occurrence of string-cut bases on Wadi Suq wares, a feature not found in the earlier contexts at Hili 8, led to the conclusion that by the very end of the 3rd millennium B.C., a set of technical innovations of Indus origin had made their way through the Oman Peninsula. At the same time, a cubic stone weight of obvious Indus origin had been found by Donaldson in a Wadi Suq collective burial at Shimal (Ash n.d.: 7). It was therefore tempting, although rather premature, to associate these innovations with the marked changes evident in many other aspects like metallurgy, stone vases, settlement and burial types, and to consider that by the end of the 3rd millennium, the "Umm an-Nar" culture had become transformed into the early 2nd millennium "Wadi Suq" culture with some influence of the Indus civilization, the latter replacing at this time, an ancient and predominantly Mesopotamian orientation.

Excavations at Maysar yielded a rather similar collection, including traits like cord impressions (Weisgerber 1984: fig. 24.4), "thumb-nail" impressions (Weisgerber 1984: fig. 24.3), Harappan-like signs engraved on the rims of jars (Weisgerber 1984: fig. 24.5) and a prismatic seal of possible Indus tradition (Weisgerber 1984: 199 and fig. 24.6). The Maysar assemblage was dated to the late 3rd millennium B.C. by its excavator, thus confirming the conclusions drawn from Hili. The 1981 discovery of a sherd displaying four engraved Harappan signs at Ra's al-Junayz (Tosi 1983), in association with what seemed to be to Wadi Suq type pottery[4], came as a *point d'orgue* to this "hunting for Indus relations" in the Oman Peninsula.

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[2] At this early stage of research it was unclear if this type of ware was restricted to the "Umm an-Nar" culture or continued into the Wadi Suq period. It is now certain that it does not.

[3] After further analysis, this sherd turned out to be of Indus origin. This had not been recognized before.

Further discoveries slightly alter this picture. Etched carnelian beads appeared in tomb A at Hili North (Cleuziou and Vogt 1985: fig. 5), where a set of possibly imported or imitated ceramics displayed Indus-like painted decoration (Cleuziou and Vogt 1985: fig. 7). It was recognized at that time that potsherds of dark coated "Indus" jars were also found in phase IIf at Hili 8, and this coincided with the fact that a few string-cut bases had already been found in the material of tomb A. The conclusions drawn from this material at the *South Asian Archaeology* meeting in 1983 was that "it is now clear that Harappan influence... in the Oman Peninsula started earlier than 2000 B.C., encompassing certainly the last century of the 3rd millennium and maybe slightly earlier" (Cleuziou and Vogt 1985: 273). However, the general impression was that the main period of Harappan influence was during the Wadi Suq period, in the early 2nd millennium B.C. This was again repeated during the *Bahrain Through the Ages* Conference in December 1983... "It is rather clear that Eastern Arabia was submitted to increasing Harappan pressure around 2000 B.C. and that it was under some strong Harappan influence during the early second millennium B.C. (Cleuziou 1986: 148, 154-155).

At the 1985 South Asian Archaeology Conference in Aarhus, the same argument was put forward in a general perspective (and reached most Indian colleagues in this shape), and research was started by the end of the same year at Ra's al Junayz (Cleuziou and Tosi 1989: 40-43 and Table 2). At the same conference, various discoveries, like a painted jar from a burial at Wadi Suq displaying similarities with Lothal and Rangpur IIA (de Cardi 1989: 12 and fig. 2)[5] were presented, again supporting a very late 3rd or early 2nd millennium date. When this paper was eventually published four years later, it conveyed an outdated picture of Indus-related evidence in the Oman Peninsula. Not only had new discoveries been made, but the complete study of Hili 8 material and also of four seasons' work at Ra's al-Junayz had altered the chronological framework. Ra's al-Junayz also provided for the first time, some of the field data necessary for the understanding of how cultural interaction between Harappa and Oman or — if one prefers Meluhha and Magan — took place.

A Tentative Chronology for Indus-Related Objects in Oman

Dark coated jars: an ubiquitous witness

In recent years, the bodies and rimsherds of well-fired Micaceous Red ware, with thick dark brown to black slip inside and a thinner black slip outside, have been discovered, or rediscovered after analysis of the material, from a majority of settlements in Oman. In the Indus area, this class has been known for a long time and was recently well described by Dales and Kenoyer (1986: 83-84). An exhaustive study by Méry (1991: 240-57) clearly demonstrates, both on morphological and archaeometrical grounds, that the sherds found in the Oman Peninsula are imported. Out of seventeen pieces found at Hili 8, two are from IId contexts, one from IIe, five from IIf and seven from III, the two remaining ones being surface finds. According to calibrated ^{14}C dates, phase IIe ranges between 2450 and 2200 B.C.,[6] and phase IIf between 2250 and 2050 B.C.[7] On this chronological basis, the presence of Indus wares in the interior of Oman begins around 2500 B.C. and continues during the whole of the second half of the 3rd millennium. Whether the sherds found in the period III context are *in situ*, cannot be decided on stratigraphical evidence, and this is more a matter of knowing the timespan during which such jars were produced in the Indus area itself. According to J.F. Jarrige (personal communication), these would occur in periods II and III at Nausharo, that is the entire period covered by the Mature Harappan. They are not found in the Late Harappan period IV. This suggests that the sherds found in the period III context at Hili 8 are not *in situ*, as confirmed by their absence in other Wadi Suq settlement contexts like Shimal[8] or Tell Abraq.

At Ra's al-Junayz sherds of dark coated jars have been found on the site of RJ-2 in the ruins of the mudbrick buildings of period II, and in ashy layers associated with the postholes of round shelters in period III. The latter are dated around the 23rd/22nd century according to a calibrated radiocarbon date[9] and a date around 24th/23rd centuries can be proposed for the mudbrick buildings of period II, in broad agreement with the Omani material found there. Dozens of such sherds were recovered from both the periods, several bearing a graffito inscription. The one mentioned earlier had four signs (Tosi 1987: fig. 105), another had three signs on the almost complete typical profile of such a jar (Cleuziou and Tosi 1990: fig. 20). Both are related to building I of period II. Three other pieces with only fragmentary signs are found in periods II and III. No sherd of this type has so far been recognized in the excavations of RJ-1 which according to ^{14}C dating and to the pottery are dated to the Wadi Suq period (Biagi *et al.* 1989). Along the easternmost part of the cape of Arabia, sherds of dark coated jars have been found in large quantities at Ra's al-Hadd site HD-1 where they represent 41% of the 515 Bronze Age sherds registered during the 1988 season (Méry, in press). The general context is certainly the second part of the 3rd millennium B.C., but it is difficult to be more precise at the moment.

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[4] The author claims responsibility for the misleading identification, made from a photograph, of associated painted sherds as Wadi Suq pottery.

[5] This tomb 6 at Shimal is the same one where the cubic stone weight previously mentioned was also found (de Cardi 1989: 9).

[6] Dates for Phase IIe are Mc2265: 3900±100 (CRD 2765-2145), Mc2264: 3840±100 (CRD 2636-2005), Mc2260: 3830±90 (CRD 2630-1990).

[7] Dates for Phase IIf are Mc2261: 3710±90 (CRD 2515-1865) and Mc2262: 3690±90 (CRD 2510-1865).

[8] Sherds of black coated ware have been found there, but in the "Umm an-Nar" context.

[9] Dates obtained from shell samples are Beta 25903:3 760±100 bp (CRD 2393-2034, one sigma) and Beta 25905: 3820±90 (CRD 2468-2076).

On the Gulf coast, black coated jars have not been published from Umm an-Nar, but are said to have been found there in a small quantity (al-Tikriti 1985: 16).[10] A large number were recovered from Ra's Ghanada site 1, north of Abu Dhabi (al-Tikriti 1985: pl. 13 n° 2), where they were associated with Mesopotamian ware of possible ED III origin (al-Tikriti 1985: 13) and can therefore be dated to the 24th century B.C. or earlier.[11] A few sherds were found at Tell Abraq (Potts 1990: 41) and Shimal (Franke-Vogt *et al.* 1987: 88), in association with the 3rd millennium "Umm an-Nar" pottery.

In the interior, the small collection from Hili 8 finds a counterpart at Bat where Méry (1991: 242 note 2) counted about twenty sherds, while their sporadic occurrence is reported from Wadi Far, Araqi, Amlah, Maysar, Bilad al-Maidin (Méry 1991: 241 note 2) and Bidya 2 (al-Tikriti 1989b: pl. 81A). The most outstanding discovery to date was made at Asimah, in a remote valley of the Omani mountains, where a total of 336 sherds (about one third of the pottery found) were associated with fine Black-on-Red Umm an-Nar pottery which can be compared to phases IId and IIe (and possibly IIc) at Hili 8 (Vogt 1988). At least three of these sherds were engraved with signs which can be related to the Harappan script.

Other pottery types found in settlements

At Hili 8, two sherds of the dish-on-stand type with concentric rows of "thumb-nail" impressions made in the local Orange Sandy Tempered ware have been found. One piece, already mentioned, was from a period III context, but such ware was no longer being produced during period III[12], and the other is from a IIe context (Cleuziou and Tosi 1989, fig. 11 n° 3). A similar sherd has already been reported from Maysar 1 and another has been more recently reported from Bat (Méry 1991: 261). Another fragment of a dish-on-stand in a fabric similar to the dark coated jars, but without impressions, was also found at Hili 8 in phase IIe (Cleuziou and Tosi 1989 fig. 11 n° 4), while two fragments of a stand are present at Ra's al-Hadd HD-1 (Méry 1991: 261; Méry, in press fig.1 n° 6).

A small jar painted all over with a Black-on-Red decoration of naturalistic peacocks and geometric patterns was found smashed on a floor of room VI in building I, period II, at Ra's al-Junayz (Méry 1988, fig. 35). This finds its best parallels at Lothal A (Rao 1973: 96, fig. 23 and pl. XXVII C, XXVIII D) and Harappa (Rao 1973: pl. XXVII A, pl. XXVII C, 3rd upper left, from cemetery R 37). Several sherds of large jars in Red Micaceous ware with black painted naturalistic decoration similar to Marshall's group AG 1 (1931: 313-314) or Dales and Kenoyer's class 2 (1986: 78-81) have been found at Ra's al-Hadd HD-1 (Méry, in press: fig. 2: 1, 3-8), and belong to the Mature Harappan, if not earlier. A few other types from HD-1 and RJ-2 listed by Méry (1991: 262) also belong to Dales and Kenoyer's categories 16, 22 or 23, 26 and 35.

The discovery of Indus-related pottery in the Wadi Suq context has already been reported from tomb 6 at Shimal (de Cardi 1989: 12 and fig. 2). This was a red jar with painted groups of dark horizontal thick lines for which comparisons in Gujarat were suggested. At Tell Abraq, the everted rim of an orange jar with black painted horizontal bands is also considered as Harappan (Potts 1990: 61 and fig. 73). These examples recall those suggested for early City II at Bahrain. Such comparisons are acceptable to a certain degree, but they still await confirmation from archaeometrical analysis.

Pottery found in graves

A set of small bottles in fine Red ware with black painted decoration combining geometric, floral and zoomorphic designs was found in tomb A at Hili north (Cleuziou and Vogt 1985: fig. 7 n° 3-8), most of these are clearly related to the common Indus valley patterns (Cleuziou and Vogt 1985: 264-266). At that time, and in the absence of pottery analysis it was not possible to decide whether these were imitations or imports. This group of sixteen vessels from tomb A (0.4%) has now been studied by Méry. Under microscopic examination all appear to belong to the same group, and one which is never associated with other types of decoration on the fine Red ware pottery of tomb A. Neutron Activation Analysis shows an incompatibility with the Omani environment. However, there is a great similarity between these results and those obtained on black coated jars, therefore it is concluded that these are of Indus origin (Méry 1991: 266), although direct morphological parallels are wanting. Similar vases have been found in tomb 1059 (Frifelt 1975: fig. 15 c-e), tomb B (al-Tikriti 1981: pl. 73 b, e, f, k, n, o, pl. 76 a-c, pl. 91 o, p), and tomb N at Hili (Haddu 1989: fig. 4, 5 lower row), and tomb B in Ajman (al-Tikriti 1989a: pl. 42A). At tomb N at Hili, they are associated with a Mesopotamian Buff ware goblet of the classical "Akkadian" type (Haddu 1989: fig. 9). All these assemblages can confidently be considered as contemporaneous with phase IIf at Hili 8 (Cleuziou 1989: 64) and therefore are dated between 2300 and 2100 B.C. according to ^{14}C.

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[10] Among these may also be Frifelt (1975: fig. 13g).

[11] The excavator was careful to indicate that "a date corresponding to that of Umm an-Nar may tentatively be suggested for Ghanada 1... The only objection we can see to this date is the abundance of so-called Harappan pottery which belongs to a slightly later date" (al-Tikriti 1985: 16). This reservation is, however, no longer necessary.

[12] The difficulties in obtaining a proper sequence from a site like Hili 8 have been explained elsewhere (Cleuziou 1989: 47-49). Some 8000 potsherds (including 772 diagnostic sherds) have been recovered in period III contexts. Sixty percent of these sherds are in fact of third millennium Orange Sandy ware.

As far as pottery is concerned, it now appears clear, and contrary to what has been written previously (Cleuziou 1981, 1984, Cleuziou and Tosi 1989), that the most obvious among the imported Indus wares in Oman, the dark coated jars, appear around the 25th century B.C. and continue until 2100 B.C. As far as ^{14}C dates can be relied on, this is during the Mature Harappan period which is also the period of their production in the Indus area itself. This probably explains why they never occur at Qala'at al-Bahrain IIa. They are the dominant items, but other types are known on the coast at Ra's al-Hadd and Ra's al-Junayz, and local imitations, noticeably those of a significant Indus item (dish-on-stand with "thumb-nail" impressions) are known from several sites in the interior. At the 1979 South Asian Archaeology meeting in Berlin, the author used Hili data to suggest that string-cut bases or cord impressions may represent a set of technical innovations of Harappan origin making their way into the Oman Peninsula by the end of the Umm an-Nar period, before being fully incorporated into the Wadi Suq culture. This idea can now be reassessed. The "thumb-nail" impressions may be linked to the use of the vessel rather than to the pottery technology and should be set aside (see below). On the other hand, cord impressions correspond to a technique used in the manufacture of large jars and if the examples of Hili cannot be considered here, as they appear on the dark coated jars of Indus origin, at least part of those of Maysar seem to be linked to local pottery (Weisgerber 1984: 198). The technique was clearly in use during the Wadi Suq period at Shimal (Méry 1991: 275) and at Tell Abraq (Potts 1990: 63-64). String-cut bases, though few in number, are also known from the end of the Umm an-Nar period from tomb A at Hili North and Ra's al-Junayz RJ-2 period III (Méry 1988), and are often associated with Indus imports like the small painted jars. On the contrary, they are very distinctive of the Wadi Suq pottery at Hili 8, Shimal and Tell Abraq (Méry 1991: 276; Potts 1990: 60-61). This again is a case of the adoption of a technique of Indus origin.

Other finds of Indus origin

A prismatic stamp seal engraved with animals (caprids, cattle, a crocodile or a scorpion?) found at Maysar, displays similarities with Harappan three-sided clay "amulets" (During-Caspers 1983; Weisgerber 1984: fig. 24.7), although comparisons with Crete, Syria, Egypt or even Central Asia are possible (Potts 1991: 112). Weisgerber (1984: fig. 24.6) however, takes account of a similar object found in grave 1 at al-Hajjar, Bahrain, which displays a typical "Indus" bull on one face and three indisputable signs of the Indus script on the other. The most outstanding discovery however, was made in room VI, building I at Ra's al Junayz, in association with the smashed painted jar (Cleuziou and Tosi 1990, fig. 18). It is a small (2.2 x 2.4 cm) square stamp seal of copper, completely corroded, which on Computer Enhanced X-ray examination revealed a classical Harappan pattern — that of a unicorn (or a bull) in front of a stand under three (?) signs of the Indus script. A similar silver object depicting a unicorn was found at Mohenjo-daro, in block 9, house XII (Mackay 1938: pl. XC n° 1). Another one of copper, also with a unicorn (?) was found at Lothal (Rao 1973: 94 and fig. 21 n° 12). The seal at Ra's al-Junayz is from a period II context and can therefore be dated around 2400-2200 B.C.

During the first field season at Ra's al-Junayz, an ivory comb was found in the earliest occupation layer of store-room II in building I (period II). This comb is similar to the Indian models found at Mohenjo-daro (Mackay 1938: 542 and pl. XCI n° 26) or Chanhu-daro (Mackay 1943: pl. LXXXIX n° 12), and one can therefore unhesitatingly consider it an import.

A cubic (2 cm) chert weight (26.3 g) has already been mentioned from Shimal tomb 6. Its date coincides well with the series from early City IIa at Qala'at al-Bahrain. Two more stone weights (14.20 g and 53.95 g) are now reported from Tell Abraq (Potts 1990: 42-44 and fig. 42-45), in the late Umm an-Nar context. The finds from Tell Abraq can therefore be considered as belonging to 23rd/22nd centuries and antedate those of Bahrain and Shimal.

Rimsherds of jars with engraved signs occur at Maysar 1 (Weisgerber 1984: fig. 24.5). Others were found at Tell Abraq (Potts 1990: 41 and 37) and three are known from Ra's al-Junayz. Two are from the late period II, being from an upper filling of room II in building I (Cleuziou and Tosi 1986: fig. 20 n° 3) and from building IV (David, in press), the third is from period III. At Ra's al-Junayz and Maysar, the engraved signs appear on local ware. The most common shape is a small jar with a widely everted rim, but other rim shapes do occur and it cannot be said at present if this is significant or not. Whether the signs are Harappan, Harappan-like or not is another difficult question to answer. Similar signs appear later on different rimsherds at Failaka (Hojlund 1987: fig. 712, 716) and further study is certainly needed to reach a better understanding of these.

As copper is often considered to be one of the possible exports from Oman to the Indus Valley, a quick look at the metallurgy seems necessary. An early survey by During-Caspers (1970b) did not yield any significant comparison, since few Omani objects were known at that time. More accurate evidence may be the presence of long blade-axes found in tombs at Umm an-Nar (Frifelt 1975: fig. 46 right ; Cleuziou 1979: 43) and Maysar (Weisgerber 1981: abb. 34), which are comparable to well-known Harappan types. The idea has been recently revived after the discovery of a similar object (Weisgerber 1981: fig. 34-36) in the late Umm an-Nar layers at Tell Abraq by Potts (1990: 41). He suggests a possible Indus origin for such items (Potts, in press). As a matter of fact, the only available metal analysis (Berthoud 1979: 109-11 and table 5 n° 2020) is fully compatible with Omani copper ores. Moreover, these are the products of a simple casting metallurgy and anybody interested in tracing other links can do so. The similarity is high, for instance, with the Chalcolithic metallurgy of Susa and Palestine, and noticeably with the objects from Nahal Mishmar (Bar-Adon 1980: fig. 166). Emphasis on the unity of Arabian prehistory, an idea to be seriously considered, might help to emphasise this link as well.

Beads found together with seals are among the earliest recognized indicators of trade, and the best known are the etched carnelian beads found in the Royal Graves at Ur and elsewhere in Mesopotamia and Iran. These have been recorded in tombs A (Cleuziou and Vogt 1985: fig. 5 n° 1, 2) and B at Hili North, and tomb B in Ajman (al-Tikriti 1989a pl. 46 T, U, 58 B). Beside these objects of undisputed Indus origin, carnelian is widespread in the tombs of the 3rd millennium in Oman, although the origin of the raw material and/or the place of manufacture requires further investigation.[13] One should note, for instance, a multi-faceted biconical carnelian bead from the late 4th/early 3rd millennium cairn C in the Jabal Hafit (Cleuziou *et al.* 1977: fig. 17 n° 8). Many other classes of beads may be considered imports, such as the silver segmented beads from tomb A at Hili North (Cleuziou and Vogt 1985: Fig. 5 n° 4) or tomb B in Ajman (al-Tikriti 1989a pl. 46 W). The same is probably the case for the fritte beads with lengthwise grooves found in a late Umm an-Nar context in tomb B in Ajman (al-Tikriti 1989a: pl. 46 D, Zb, 56c) or Ra's al-Junayz RJ-2 from period III (Cleuziou and Tosi 1990: fig. 19 n° 4).

An interesting point may be raised here. Hundreds of tiny beads of an artificial material, usually thought to be fritte or faience, but more likely to be white heated steatite, have been found as early as the late 4th millennium B.C. in the Jabal Hafit cairn burials (Frifelt 1970: 380; Cleuziou *et al.* 1977: Fig. 17 n° 6). These were found with square spacers of a similar material displaying clear similarities with objects found in Mesopotamia (Frifelt 1970: 380; Cleuziou and Tosi 1989: fig. 1) therefore turning the comparisons westwards, but one might conjecture that the strong emphasis on relations with "Jamdat Nasr" Mesopotamia was the main reason to focus in that direction. It has, however, already been suggested (Cleuziou and Tosi 1989: 30) that relations eastwards should also be examined, as white heated steatite is a well-known product from the Indian subcontinent, where it is found at Mehrgarh III as early as the late 5th millennium B.C. (Samzun 1987: 76). Another common item in the Umm an-Nar tombs are small tubular beads, up to 3 cm long and 0.3 to 0.5 cm in diameter with a very narrow perforation. These were found at Umm an-Nar cairn V, assembled as the remains of a "plastron" (Thorvildsen 1964: fig. 16) and considered by the excavator as made of bone, probably bird bones. Similar beads, made of white heated steatite, have been found by the author and others in tomb M at Hili (second quarter of the 3rd millennium B.C.), and in phases Ib and Ic at Hili 8 (early 3rd millennium B.C.), and apparently are nowhere reported from late Umm an-Nar burials. This may lead one to entertain the idea that relations with one of the formative areas of the Indus civilization could already have been active in early 3rd millennium Oman. Whether objects were imported, or made in Oman with a technology obviously linked to the "Indus" technology, is a matter which cannot be investigated at present. However, it may be suggested that beyond the links generally acknowledged with southeastern Iran (Méry 1991: 121), more distant relations with the western areas of Early Harappan cultures deserve to be further investigated.

Interpretation

Indications of Omani contacts with the Harappan world can be traced for every period from the first part of the 3rd millennium B.C. (Early Harappan), through the second part of the 3rd millennium (Mature Harappan) where they are numerous, and during the early 2nd millennium (Late Harappan). Such continuous interaction between neighbouring civilizations is not surprising, even if it is often not archaeologically established. Material evidences are of great interest to archaeologists in a technical way, as they help to establish chronology, as has been the case, for instance, in the use of "Jamdat Nasr" vessels in the cairn burials of Oman. It should be noted though that misleading data combined with conflicting chronologies can lead to such problems as those examined at the beginning of this paper. Their real use, however, lies elsewhere — in a precise contextual study to understand how both areas interacted. This is why the Ra's al-Junayz project was initiated in 1985 and aside from the technical aspect (it generated new data for the construction of a chronological framework) this was one of its main contributions. The interpretative framework is the one presented in the Aarhus paper of Cleuziou and Tosi (1989), and if the temptation was great in the early days to crudely interpret the site as "a new Harappan seaport" in a foreign country, it was a constant endeavour, during five seasons' of work, to understand, piece by piece, the proper place of Harappan elements within the local cultural context. Such projects are long term and it would certainly be premature to present here a complete interpretative picture, which ought to be coroborated by a study of all aspects of the material culture in the area. A few hypotheses however, have been proposed which are of interest in the more general interpretation of relations between Oman and the Indus civilization.

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[13] If carnelian is generally reputed to come from the region of Cambay, some minor sources are reported from the Arabian Peninsula and the Iranian coast near Bushir (Whitehouse 1975).

The formative and early period of the Umm an-Nar culture

Very little can be said regarding the first part of the third millennium B.C., but contacts with the western margins of the Harappan world were probably already more important than is sometimes suspected. In their Aarhus paper, Cleuziou and Tosi (1989) suggested that elements from the Indo-Iranian borderlands could have played a vital role in shaping Oman's 3rd millennium culture, for example, the herding system dominated by cattle as outlined by H.P. Uerpmann, from his preliminary archaeozoological analyses at Hili 8, which recall the 4th millennuim patterns reconstructed for Baluchistan by Meadow (1984). The earliest Black-on-Red painted wares found at Hili 8 in period I display a general similarity with Iranian types (Cleuziou and Tosi 1989: fig. 6), but archaeometrical study has shown that they were produced from local clays, and belonged to a tradition which remained in use during the whole of the 3rd millennium B.C. Méry (1991: 333), based on this has suggested the presence of specialized potters, using a wheel and elaborate kilns, as early as 3000 B.C., indicating that the pottery technology must have come from the Indo-Iranian borderlands sometime during the 4th millennium.[14] The making of white heated steatite could have followed as well, as all these pyrotechnologies are similar to those employed in early copper exploitation. The database at hand is unfortunately still too small to draw further conclusion.

"Mature" Umm an-Nar and Mature Harappa

The most obvious period of direct Harappan imports was during the second half of the 3rd millennium B.C., which corresponds to a time when the "Umm an-Nar" civilization of Oman was attaining a greater degree of integrity. Black coated jars were containers used in trade — and more precisely maritime trade — as suggested by their volume (20-70 litres) and shape, which recall an amphora and appear specially well designed to fit into the hull of a boat (Méry 1991: 254-245). The presence of these black coated jars in the coastal settlements of Ra's al-Junayz, Ra's al-Hadd and Ra's Ghanada, fits in with the idea. From here, they frequently travelled to the interior but it has not been possible to ascertain if it was with their original contents, or some other contents, or even empty. In a recent study of the role of dairy products in the Indus civilization, Gouin (1991) has suggested that at least one of these products could have been a variety of dried cheese (similar to Turkish *qurut* or Persian *kashk*). In his reconstruction of the technique of dairy processing, the same author based on ethnographic parallels suggests, that the dish-on-stand was used as a serving dish for the small balls of dry cheese. According to him, the concentric "thumb-nail" impressions often considered a decoration were actually a technical device: a cheese grater. The presence of sherds of the dish-on-stand at Hili, Bat and Maysar may be interesting in this respect.

Dark coated jars were never imitated in the local ceramic, and probably could not be imitated by Omani potters who did not have the technical skill to produce such large vessels until the very end of the Umm an-Nar period (Mery 1991: 268 and 324). These jars were used to carry products of foreign origin and perhaps re-used, as large pottery containers were not locally available. Other types of Indus pottery only came from places involved, to some degree, in maritime trade, or belonged to a particular class of people who used (or re-used) them in burial practices. None of these types, with the exception of the dish-on-stand, was ever imitated in the local wares nor were Indus-like decorations, although obviously they were known. The technical interpretation (consumption of Harappan imported product) proposed by Gouin (in press) would be a very satisfactory explanation for the presence of local imitations of "thumbnail" impressions on the local dish-on-stand. To be provocative, it could be said that whatever the importance of contacts — and everything seems to indicate that they were important — the study of pottery suggests that the country of Magan traded or exchanged goods with the urban Indus civilization, but its material culture was not basically affected. There are some arguments in favour of the same idea when one examines other classes of artefacts. For instance, the common type of fish-hook in use at Ra's al-Junayz or Ra's al Hadd is a simple one (Cleuziou and Tosi 1988: fig. 19; Reade 1990: fig. 35) found all along the Arabian coast up to Kuwait, and not a single barbed hook with attachment loop of the Indus type was ever found in the Peninsula. Towers with a compartmented solid base are the typical architectural feature of the interior oases. They are also the main monuments of Tell Abraq (Potts 1990) and cannot therefore easily be considered as Harappan, nor can the mudbrick houses of Ra's al-Junayz which were built in a technique known at Bat in interior Oman (Frifelt 1989), but without any parallel in the Indus area (Cleuziou and Tosi

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[14] The term "specialized" is used by S. Méry in accordance with the fact that the technical skills necessary for wheel-thrown pottery require specialized training (Roux and Corbetta 1990).

The presence of specialized potters as early as 3000 B.C. does not, however, conflict with the idea that this production was still not fully integrated into the cultural system of the Peninsula as suggested in Cleuziou and Tosi (1989). The pottery in burials were foreign products (imported from Mesopotamia) and the generalized use of pottery starts only a few centuries later.

1990: 11 and fig. 10). More detailed studies are necessary to assess, for instance, the status of items linked to management techniques like cubic stone weights (Tell Abraq), Harappan seals (Ra's al-Junayz) or signs on jar rims in the Omani culture.

According to the testimony of the black coated jars, "invisible imports" from the Indus civilization, be they dried cheese or any other kind of food, were involved in exchanges. Luxury goods like ivory combs, etched carnelian and silver beads, and many products of the Indus workshops were in demand. Eventually one could assume that textiles, this invisible but omnipresent component of international trade, also reached the Oman Peninsula from the Indus, as they did from Mesopotamia. In turn, Oman probably had very little in the nature of manufactured items to offer,[15] and raw materials (e.g. copper) were certainly their main export, although this remains to be demonstrated. The use of this overseas copper source in the Indus valley is often questioned, and should be examined through a comprehensive archaeometrical study. Oman may be much further away than other copper sources in the Indian subcontinent itself,[16] but one should recall that there are also closer copper sources around Mesopotamia than those obtained from Oman. Water transportation may have proved advantageous for this kind of cargo, considering that we have for long, probably underestimated the level of seafaring technology. It should also be noted that contrary to what seems to have been happening in 3rd millennium southern Mesopotamia and Susiana, where copper was predominantly imported from Oman, the much larger Indus area may have depended on more than one copper source. The problems raised by the possible competition of two areas importing from one single production centre should eventually be addressed (Cleuziou and Tosi 1989: 42).

What was the nature of Harappan "investment" in Oman? The possibility of proper Harappan settlements (or "outposts" or "colonies") comparable to what Shortugai could have been in northern Afghanistan has been entertained, echoing previous statements on "a possible Jemdet Nasr 'colony' in the neighbourhood of Buraimi" around 3000 B.C. (During-Caspers 1970b: 250). On present data, this cannot be completely rejected, although Ra's al-Junayz or Ra's al-Hadd are certainly not sites of that kind, and nothing comparable to the impressive fortified settlements of Sutkagen Dor (Tosi 1987: abb. 102) or Sotka Koh which controlled access between the Makran coast and the interior has ever been found in Oman. The presence of native Harappan merchants among the local population, on a model recalling the Indian population of Muscat and other places in Arabia during the last centuries, can also be suggested (Potts, in press). This would be more in agreement with the model already proposed at Aarhus in 1985: "...there are reasons to believe that Harappan artefacts were introduced in Oman as a mercantile free choice, given a system of regular seafaring exchanges..." channeled through a diffuse, and probably changing network of coastal settlements and campsites (Cleuziou and Tosi 1989: 42). Ra's al-Junayz on the Indian Ocean or Ra's Ghanada in the Gulf may represent what most of these places actually were. In the same paper, the idea was also mooted of a Harappan "colonization" of Oman by suggesting that "...most likely the penetration of these products in Oman is best explained on an interactive base involving a fair degree of control of the transport and distribution on the part of the Arabs". Here again the data gathered during excavations at Ra's al-Junayz broadly agrees with this prospective statement.

New integrations: the Wadi Suq period

At the very end of the 3rd millennium, when the Umm an-Nar culture seems to have reached its peak, Oman must have experienced a severe crisis. This lasted for a century or so, produced a complete transformation in the material culture where no aspect remained unaffected, and the culture witnessed profound social changes.[17] Problems in the interpretation of this period arose from misleading chronological data, as discussed earlier, but probably also from a misunderstanding of the significance of some comparative data, at least as far as pottery was concerned. At Berlin, the author (Cleuziou 1981: 291) considered technical traits, like cord impressions or string-cut bases, as indicators of a strengthened Harappan influence in the Oman Peninsula. Méry (1991: 275-276) has convincingly demonstrated that these technical traits of Harappan origin are incorporated in the new technical system by the Omani potters where everything differs from the previous Umm an-Nar tradition, which had remained stable almost throughout one millennium. These traits include new shapes, new decorations, a new choice of materials, new techniques of shaping, etc. (Méry 1991: 336), most of them alien to the Harappan tradition. Therefore, the possibility sometimes entertained, that a period of acculturation may have followed one of actual colonization (Brunswig *et al.* 1983: 104 ff) is certainly an oversimplification, as suspected by Potts (in press).

An alternative proposal would be to link these changes in pottery technology with the overall changes experienced along the Indo-Iranian borders and in the Indian subcontinent at the end of the Mature Indus period. It is probably not mere chance that these Harappan traits became integrated, among others, in a new technical system at a time when the whole Indian subcontinent was experiencing changes which led, in a rather short time, through the Late Harappan to the post-Harappan cultures. The phenomenon has already been described as rapid transformations of the material basis of the economy linked to the introduction of new cultivars and new domesticated animals (Meadow 1984). In other words, after a long period of stability represented by Mature Harappan cities on one side of the Arabian Sea and by the modest level of the Umm an-Nar oasis complexes on the other, and as a result of factors which can be suspected but are not evident in the archaeological data, centuries of stability were broken and major recombinations of material elements occurred leading to new ways of life and new organizations of society. Techniques or artefacts which were known to each other but not actually used, were introduced in the new complexes, like for instance, certain Indian pottery techniques (e.g. the use of cords to produce large containers or string-cutting) into Oman, or sorghum cultivation — a long time Omani cultivar — into the Indian world.

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[15] The oft quoted chlorite ball of *serie recent* found at Mohenjo-daro (Cleuziou and Tosi 1989: Fig. 16) is still the only object of probable Omani manufacture found in the Indus area.

[16] For example, the Shagai Hills in northwestern Baluchistan or the Khetri copper belt in northern Rajasthan.

[17] This is, for instance, evident from funerary customs. The strict separation of the various parts of the collective multi-chambered burials of the Umm an-Nar period is such that it must have been significant at this level of social organization and that is why they were replaced by long single-chamber collective burials (Qattarah, al-Qusais, Shimal, Bidya, etc.) or single burials.

In historical terms, Wadi Suq cultures are linked to City II at Qala'at al-Bahrain, as demonstrated by the occurrence of Early City II pottery in early Wadi Suq levels at Shimal and Tell Abraq (Potts 1990: fig. 72, 75, 77). On the other hand, Indus-related items appear now to be found either in unreliable contexts (dark coated sherds from Hili 8), in graves were they have been put after a long period of local use (the weight from Tomb 6 at Shimal) or are themselves not very characteristic (Red jars with painted black horizontal stripes at Tell Abraq and Shimal tomb 6). The fact that similarities with objects from Lothal or Rangpur are often looked for by archaeologists is, however, not pure chance. In this phase of regionalization, densely populated post-Indus Gujarat, with its large cities and maritime trade, appears a most attractive area for settlement. At the same time, the Wadi Suq culture of Oman extends to the copper rich island of Masirah (al-Shanfari 1987) which does not seem to have been incorporated in the previous "Umm an-Nar system". The exploitation of these distant copper sources is not likely to have been developed for the needs of Dilmun-Mesopotamian trade, nor for the needs of Oman itself.

New evidence for interaction may emerge along the northern rim of the Arabian Sea, but as data is presently lacking, one can only end with this common, pessimistic archaeological conclusion that "more data is needed". Two decades of research in the area have, however, at least created the necessary conditions to put further discoveries into a new interpretative framework of a protohistoric exchange network among countries of the Erythrean Sea.

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Padri Ware: A New Painted Ceramic found in the Harappan Levels at Padri in Gujarat

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Abstract

The discovery of a new painted ceramic termed "Padri ware" in the Harappan levels at Padri in Gujarat, has raised a number of questions regarding its genesis, relationship with the Harappan culture and the people responsible for its manufacture. According to the authors the occurrence of this ware in the Harappan levels was possibly due to contact between the Harappans and some village-based farming communities, or hunter/gatherers contemporaneous with them.

Introduction

Padri (22° 22' N; 72° 95 E') is an ancient site in the Talaja taluka of Bhavnagar District, Gujarat (for details of site location and other features see Shinde 1992). The recent excavation conducted at the site revealed a two-fold cultural sequence, namely Early Historic and Harappan. The former can be dated to the 1st century A.D. on account of the discovery of a copper coin similar to those issued by the Kshatrapa king, Nahapan and a clay tablet bearing Brahmi script. The Harappan phase, on the other hand, is comparable to Rojdi B, which has been dated to c. 2200-2000 B.C. (Possehl and Raval 1989). Among the noteworthy artefacts found in the Harappan levels at Padri is the terracotta seal bearing an incised fish pattern, which is believed to be a Harappan sign. The other new features of the Harappan Civilization in Gujarat, which this excavation has brought to light, include rectangular mud structures, some of which are found to be interconnected and a new ceramic, which has, so far, not been reported from any other site. Besides, it has been hypothesized that the site was selected to facilitate the manufacture of salt, which then could have been supplied to other hinterland settlements in exchange for various essential commodities (Shinde, in press).

The Padri Ceramic Assemblage

The ceramic assemblage from Padri can be divided into two broad categories, namely fine and coarse ware. The former includes the Sturdy Red ware and Buff ware. Both these were made on a fast wheel as the uniform striation marks and even thickness of the pots would indicate. They were made from a very fine levigated clay and a considerable amount of fine marine sand was added as a tempering material. Both these wares can be sub-divided into a thin and thick variety. The thick variety is mostly represented by large globular storage jars with either beaded or clubbed rims and small flat bases; also by cylindrical perforated jars, large shallow dishes with incurved sides and beveled rims and a few step-sided dishes with hollow flared stands. The thin variety includes types like convex-sided bowls with either featureless or slightly everted rims, goblets with flat bases, small basins, dishes and globular pots. Three unique painted storage jars were also found. On the surface of the largest jar is a black painted, standing human male figure wearing a horned headdress. This figure has been identified as that of Pasupati, "Lord of Beasts" (Shinde 1991a and b).

The coarse variety of ceramics is represented by two types, the Red/Grey and Padri. The Red/Grey ware is made from a very coarse clay, to which was added chopped grass and sand as tempering material. This is medium thick in section and is wheel-made. It bears a grey slip on the outer surface, but sometimes blotches of red colour are also found on it. The ware is unpainted but sometimes applique or punctured decorations on the neck and shoulders can be discerned. A medium-sized globular pot with out-turned rim is the predominant type, whereas the other types such as the

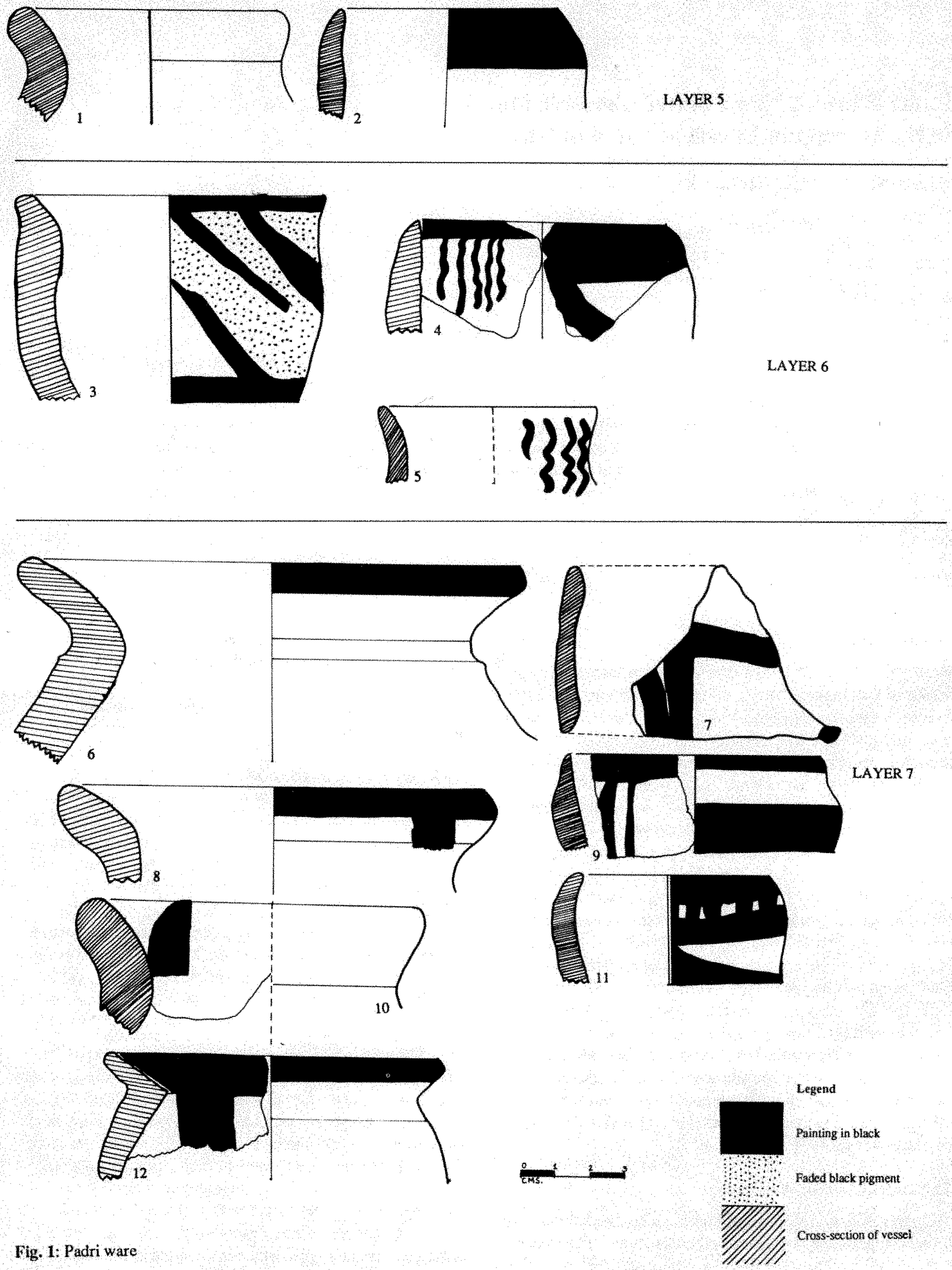


Fig. 1: Padri ware

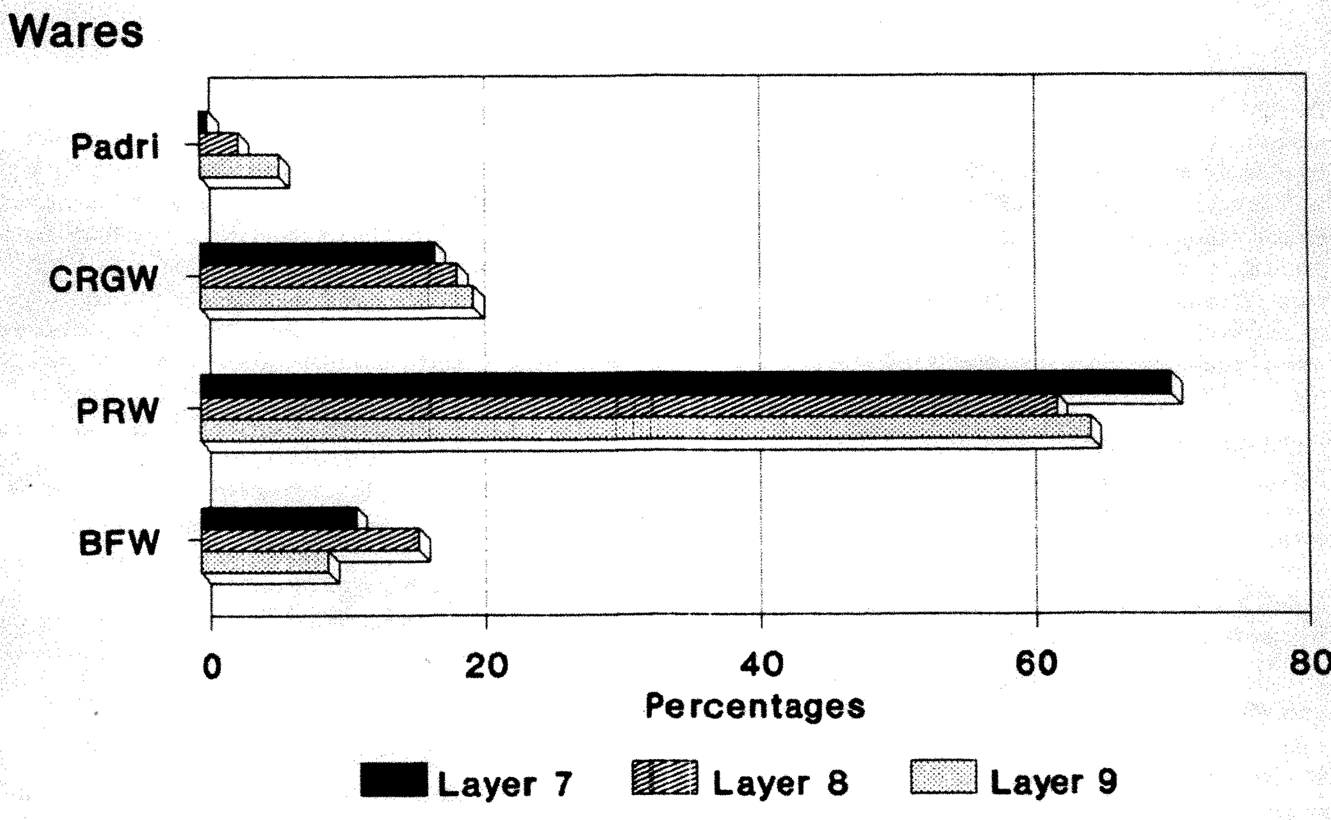
dish and small basin are very rare in this collection. The second type of coarse ceramic is Padri ware, which is painted.

Padri Ware

A small number (299 out of a total of 8791 sherds found in C3 and J2, Fig. 1 and 2) of sherds of a new painted ceramic have been collected from the Harappan levels at Padri (Shinde 1992 and Shinde, in press). A couple of sherds of this ware were found in the Early Historic levels, but their occurrence could be due to disturbances by burrowing rodents or foxes digging holes. This ceramic, which has not been reported from any other Harappan site, was named "Padri ware" after the site. It is made from a coarse clay to which a considerable amount of sand has been added as tempering material. The ware is medium thick in section and the non- oxidized core suggests that it was not well fired. The outer surface of the pots, and in the case of wide-mouthed pots like bowls, the inner surfaces also were treated with a thick coating of red slip, which shows a tendency to develop cracks. The thick slip seems to have been intended to conceal the coarseness of the clay.

The Padri ware is represented only by two types — convex-sided bowls and globular pots. Interestingly this ware includes a couple of sherds of perforated jars, similar to those found in the Harappan Sturdy Red ware. The bowl is the predominant type, constituting over 60 % of the total forms, with a considerable variation in body shape. The various forms include convex-sided bowls with featureless rims (Fig. 4, No. 2 and4), deep bowls with either straight or incurved sides (Fig. 4, No. 7 and 11; Fig. 3, No. 14, 16 and 18) and bowls with slightly everted rims (Fig. 4, No. 3). In addition, there is one fragment of a concave carinated bowl (Fig. 4, No. 5), similar to those found in the Malwa levels in the Deccan. As the lower portion of this bowl is broken it is difficult to determine whether it had a flat base like most of the Harappan painted bowls.

There are two main varieties of globular pots: small with short out-turned rims, possibly having circular bases, and medium-sized pots with slightly beaded or out-turned rims (Fig. 4, No. 1, 6 and 12; Fig. 3, No. 17). There is one fragment of a medium-sized basin with a flat projecting rim (Fig. 3). The irregular striation marks and uneven thickness of pots suggest that this ware was made on a slow-turned table or even by hand modelling. Painted decorations consist mainly of linear patterns such as vertical and horizontal bands, groups of vertical and horizontal bars, thin vertical wavy lines, short vertical strokes in a panel of broad horizontal bands, a chevron pattern and short vertical strokes on



Padri-Padri Ware ***CRGW-Coarse Red/Grey Ware*** ***PRW-Painted Red Ware*** ***BFW-Buff Ware***

Fig. 2: Temporal distribution of Padri ware in relation to other wares in C3

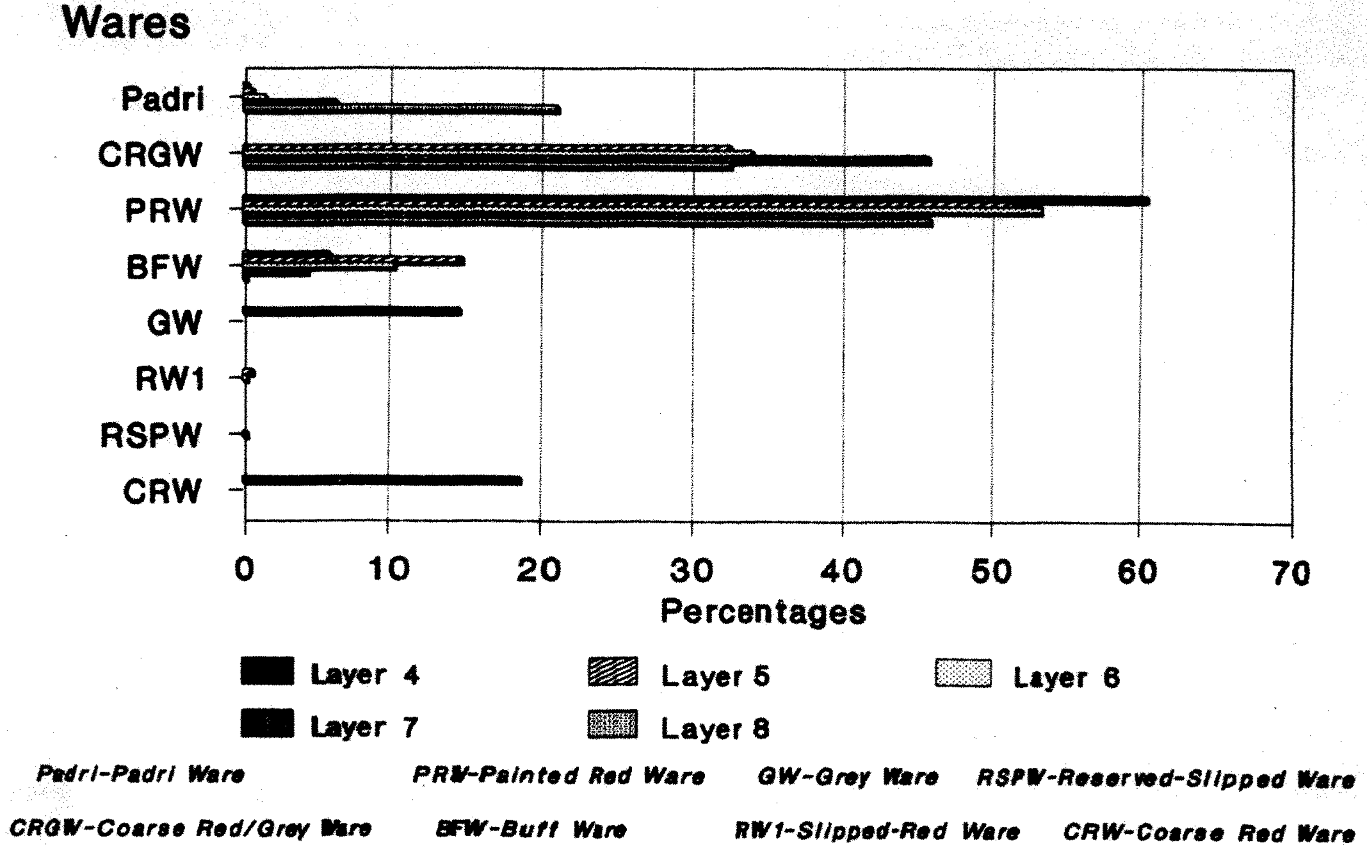


Fig. 3: Temporal distribution of Padri ware in relation to other wares in J2

the rim of the pot above a broad horizontal band. The designs, executed in black, appear to have been carelessly done, as the broken and uneven thickness of painted lines as well as the drips of paint would indicate. The designs are found to be strictly confined to the upper parts of vessels, but in the case of the wide-mouthed pots, vertical strokes are also found on the inner portions of the rims. The temporal distribution of Padri ware in relation to other major wares found in the index trenches C3 and J2 is given in Fig. 1 and 2.

From the distribution chart (Fig. 1) it is clear that the perncetage of the Padri ware in C3 increases from 0.66% in layer (7) to 5.82% in layer (9) and in J2 from 0.33% in layer (4) to 21.16% in layer (8). The high concentration of Padri sherds in layers (9) and (8) in C3 and J2 respectively is mainly because of the concentration of dwelling units represented by rectangular mud structures.

In this connection it should be noted that there is a great deal of similarity between the Padri ware and the "Savalda ware" which has been reported from sites like Savalda in Nandurbar Taluka (Sali 1964) and Kaothe in Sakri Taluka in the central Tapi basin (Dhavalikar and Shinde 1987; Dhavalikar *et al.* 1990). The Savalda pottery is rather coarse, is both thin and thick, and the vessels have a red or pinkish slip, which is thick and tends to develop cracks. From the rather unevenly shaped vessels, it appears that many of them were handmade or turned on slow wheels. The core is often gritty indicating that it contains impurities. It is also non-oxidized suggesting that it was not fired at a uniformly high temperature. The painted designs executed in black pigment not only include most of the geometric patterns found on the Padri ware, but also motifs of a variety of animals, birds, fish and weapons. As far as forms are concerned, there were a few convex-sided bowls, similar to the Indian lota but with very narrow and high necks, also globular jars with short out-turned rims (Dhavalikar and Shinde 1987; Dhavalikar *et al.* 1990). Although the major focus of the Savalda culture was in the Dhule district of Maharashtra (Shinde 1990), the ceramic is also reported to occur as far south as Daimabad in the Godavari Valley, Ahmednagar District, Maharashtra (Sali 1986). It is interesting to note that so far not a single Savalda culture site has been reported from the states bordering on Madhya Pradesh or Gujarat, where similar ecological conditions prevail.

Discussion

Considering the sporadic occurrence of the Padri ware, and its difference from Harappan pottery in terms of raw material, technique of manufacture and limited number of types, there is hardly any doubt that this ware was not manufactured by the Harappans. It would have been feasible, both economically and socially, for the Harappans to employ the

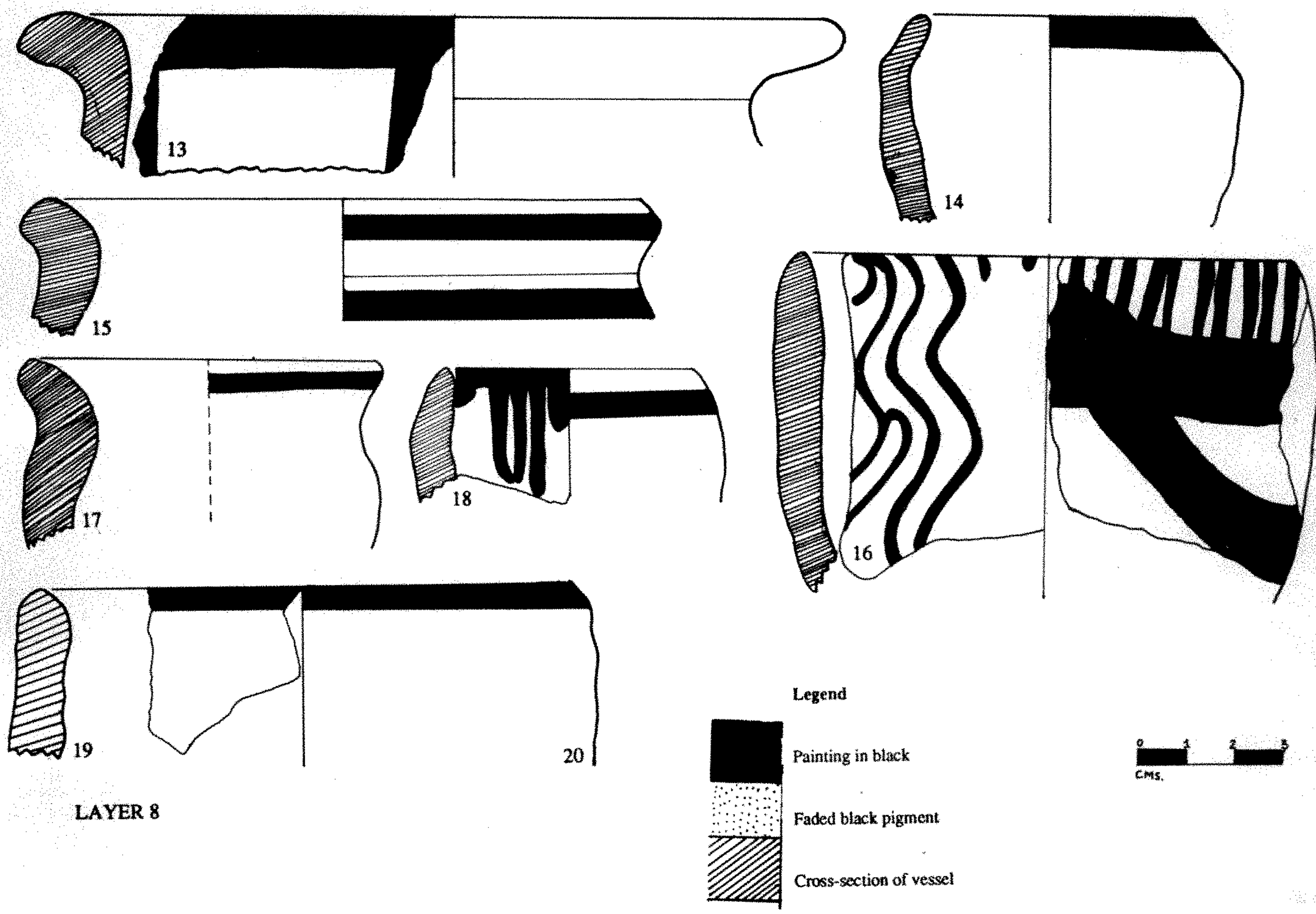


Fig. 4: Padri ware

same technique and exploit the same source of raw material for the production of Padri ware. Had it been produced by the Harappans, it is logical that the ceramic would have been mass produced. There appear to be a number of possibilities and one of them is the exchange of cultural traits between the local cultures and the Harappans in Gujarat. This is supported by Possehl's (1976) suggestion that the site of Langhnaj was a hunter/gatherer encampment, where there was cultural interaction between the local inhabitants and their Harappan neighbours. This suggestion was based on the presence of a pure copper knife at Langhnaj, along with Harappan-type steatite beads and Black-and-Red ware. It was also interesting to note that the examination of the human skeletal remains from the cemetery at Lothal revealed features which can be associated with hunting and gathering populations like those from Langhnaj (Ehrhardt and Kennedy 1965). This indicates that there was gene flow between the Urban Phase Harappan population of Gujarat and their hunter/gatherer neighbours (Possehl and Kennedy 1979).

There would have existed some sort of symbiotic relationship between the Harappans and the local people in the form of masters and servants/labourers respectively. The former could have depended, entirely or partially, on the latter and exploited their labour potential by offering them temporary employment in their processing units in return for a steady supply of essential commodities. In this respect the evidence from Kuntasi is worth mentioning. Kuntasi, a Harappan site in the Rajkot district of Gujarat has been identified as a centre that was established for the full-time manufacture of items like paste beads and painted pottery. The archaeological deposit outside the fortification area yielded coarse painted pottery and scanty occupation debris. No permanent structures were noticed. It was, therefore, surmised that the area was inhabited by local hunter/gatherers, who could have worked as part-time labourers in the industrial complex set up by the Harappans. These people probably constructed wattle-and-daub huts and were supplied with essentials like earthen pots and grain by the Harappans in exchange for their services and a supply of raw materials. The very fact that they were kept out of the fortified area suggests their non-Harappan status. Recently the M.S. University of Baroda excavated a Protohistoric site at Loteshwar in the Mehasana district of Gujarat, which on the basis of different painted ceramics, has been identified as a settlement of the Chalcolithic period (Kuldeep Bhan, personal communication). This site provides further evidence for the existence of village-based farming communities in Gujarat contemporaneous with the Harappans.

Another possible explanation for the presence of Padri ware in the Harappan levels is that there was cultural contact with the first farmers of the Deccan (Savalda culture). The Savalda culture, which flourished in the northern Deccan between c. 2000 B.C. and 1800 B.C., is more or less contemporary with the Harappan phase at Padri. Sali (1986) has pushed back the chronological position of this culture at Daimabad to the period between c. 2200-2000 B.C. However, the archaeological data for contact with the Savalda people goes contrary to our suppositions. A number of protohistoric sites, particularly of the Harappan period have been discovered in Gujarat along the border with Maharashtra, but none of them have yielded Savalda ware. In the absence of evidence for migration into Gujarat, cultural contact with the Harappans cannot be ascertained. The site of Padri is very important and only a large- scale excavation will enable us to throw light on various problems such as the origin of Padri ware and its Harappan associations.

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The Relevance of the Forager/Collector Model to Island Communities in the Bay of Bengal

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Abstract

This paper examines the applicability of the forager/collector model, as postulated by L.R. Binford, in defining the subsistence systems of the Andaman Islanders and the Nicobarese.

Introduction

One of the most vital problems in the field of anthropology centres around the debate on the complex systems of human subsistence that prevail in the Andaman and Nicobar Islands (Figs. 1 and 2). The existence of sharp biological and cultural variations within these two archipelagos is a case in point. The three main aboriginal groups of the Andaman and Nicobar Islands are the Andaman Islanders (comprising the Great Andamanese, the Jarawa, the Sentinelese and the Onge), the Nicobarese and the Shompen.

In this paper, an attempt is made to determine how the above-mentioned islanders may be classified in terms of our current knowledge of hunting and gathering as well as of horticultural societies throughout the world.

The Andaman Islanders

To begin with, the complex nature of adaptation in the Andaman Islands has often been underestimated by scholars who tend to believe that the Andaman Islanders subsist primarily on coastal resources (e.g. Bailey *et al.* 1989: 63). That this is an erroneous assumption can be proved by Bose's (1964) finding that coastal resources comprise only 25% of the diet of the Onge of Little Andaman Island. Furthermore, it may be noted that the Andamans have only a narrow band of littoral resources which, in combination with the frequency of storms, and the unsuitability of the traditional outrigger canoe for voyaging in deep waters, greatly diminishes the role of aquatic food in the local economy (Erickson and Beckerman 1975).

On the other hand, the technological repertoire of these islanders is ideally suited for the efficient exploitation of inland resources (Man 1883; Radcliffe-Brown 1922). In this regard, even Oswalt (1986: 192) has remarked that the subsistence strategies of the Andamanese are generally more complicated than those of desert and tropical peoples. It is apparent, therefore, that neither geographical nor ethnic differences were strongly manifest in subsistence efficiency in the Andaman Islands.

Moreover, Morris (1982a: 455) has observed that similar tropical forest environments such as those of the Andamans and the Ghat mountains of South India, wherein dwell the Hill Pandaram, are not necessarily conducive to the evolution of uniformity in group structures among the communities involved. Thus, among the Hill Pandaram, the Kadar and the Paliyar, the family constitutes the focal unit, whereas among the Andaman Islanders, the local group emerges as the dominant social unit (Morris 1982a: 455).

The Forager/Collector Model

Since it is obvious that ecological determinants alone were not responsible for the development of the indigenous system of adaptation in the Andamans, the question naturally arises as to how the native islanders may be categorized, and whether the criteria currently employed for this purpose are relevant in this case. In this regard, Binford (1980) has offered a useful model that divides contemporary primitive societies into two categories, namely, that of foragers and collectors. The former are generally characterised by 'high residential mobility, low bulk inputs, and regular daily food-procurement strategies' (Binford 1980: 9). The collectors, on the other hand, store food for at least part of the year, and organise themselves into 'task groups seeking to procure specific resources in specific contexts' (Binford 1980: 10).

Furthermore, Binford (1980: 16) assesses Murdock and Morrow's (1970) estimate of the influence of 'effective

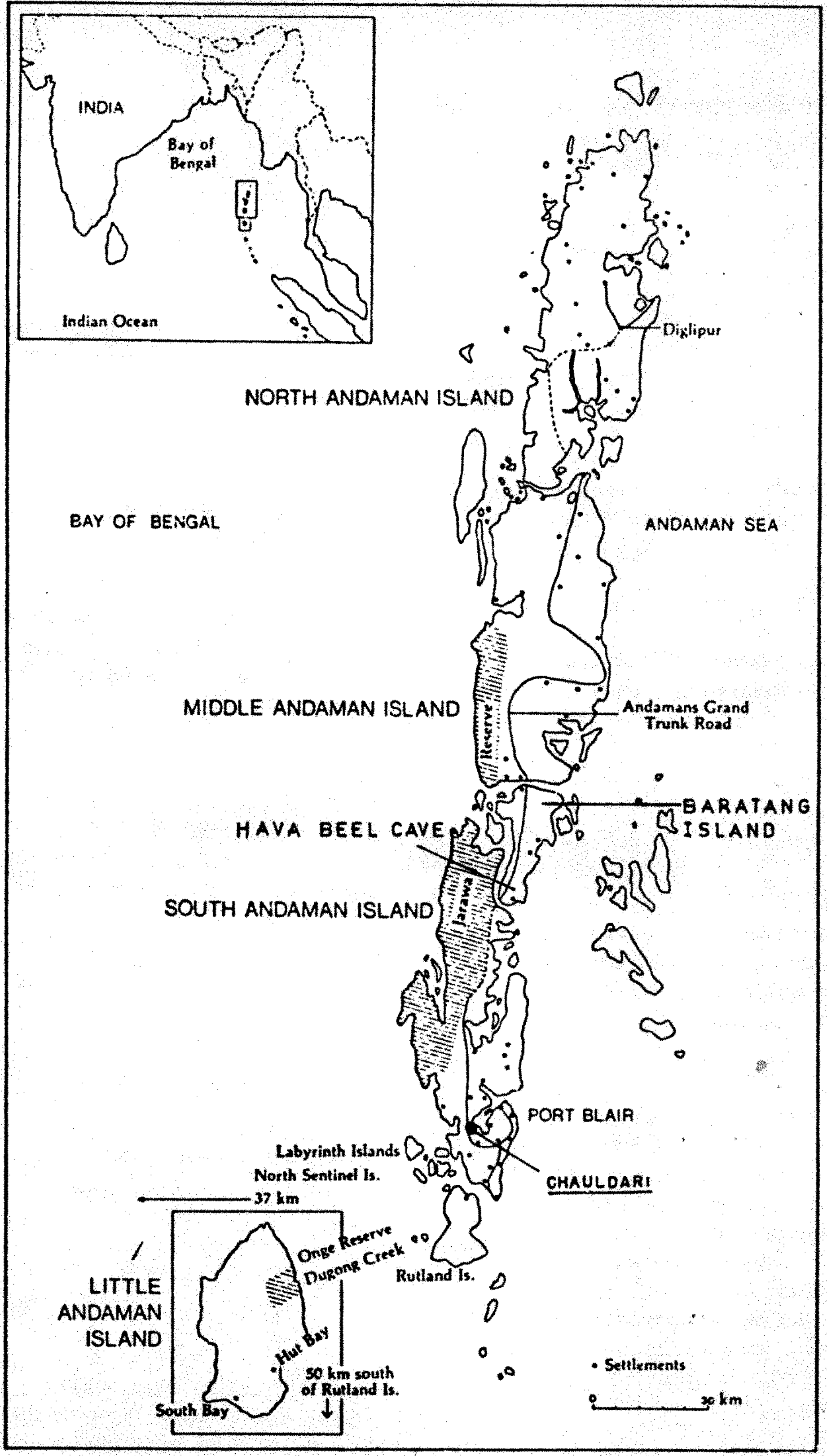

Fig. 1: Andaman Islands

temperature' (ET) on storage dependence among hunter-gatherers. Considering that storage is more widely practised in a temperate climate, as opposed to tropical environments, Binford (1980: 16) suggests that the Andaman Islanders have been miscoded as belonging to the group associated with limited storage, implying, therefore, that they should be more appropriately termed as 'collectors'.

Population Density and Factors Affecting Mobility in the Andamans

Binford has probably based his surmise on the fact that the indigenous population of the Andaman Archipelago, particularly in the major islands of North, Middle and South Andaman, as also in Little Andaman, was formerly divided into inland groups ('eremtaga') and coast-dwellers ('aryoto') (Man 1883: 102; Radcliffe-Brown 1922: 26). This ecological distinction notwithstanding, it is interesting to note that those living in the heart of the forest were reported to be more numerous than those inhabiting the coastal areas (Man 1882: 281). In corroboration of this statement, Erickson and Beckerman's (1975) study of the determinants of population density in the Andamans indicates that each square mile of forest supported slightly over two people, while the coast could only support 0.7 persons per linear mile.

It must be borne in mind that these estimates are applicable to the period prior to the establishment of the British penal settlement at Port Blair in 1858, after which a sharp decline in population has been recorded (Portman 1899). Today, the Andaman Islanders hardly comprise 400 individuals. Among these, only the Jarawa and the Sentinelese continue to adhere to traditional subsistence activities, though even these have been considerably curtailed and modified owing to the pressures imposed upon the groups concerned by a growing population of settlers. It is in view of these facts, that the subsistence practices of the Andaman Islanders have been referred to, in this paper, in the past tense.

As may be expected, the coastal groups moved camp more frequently on account of changing fishing and turtling conditions. Another factor that induced greater mobility, especially along the coast, was the stench that arose from rubbish heaps that were allowed to accumulate close to habitation areas (Man 1883: 105; Radcliffe-Brown 1922: 30). Distances between camps, however, were not great nor were semi-permanent base camps unknown among the 'aryoto'. Fig. 3 shows part of a temporary encampment of the Onge in South Bay, Little Andaman Island. This camp was encircled by a ring of debris.

Fig. 4 illustrates the process of cutting bamboos for arrow shafts. These are later heated over the fire and straightened by hand. The shafts are then stood up round the fire as shown in Fig. 5. Such activities can be expected to have been carried out on sites that were associated with relatively long-term occupation, whether along the coast or inland.

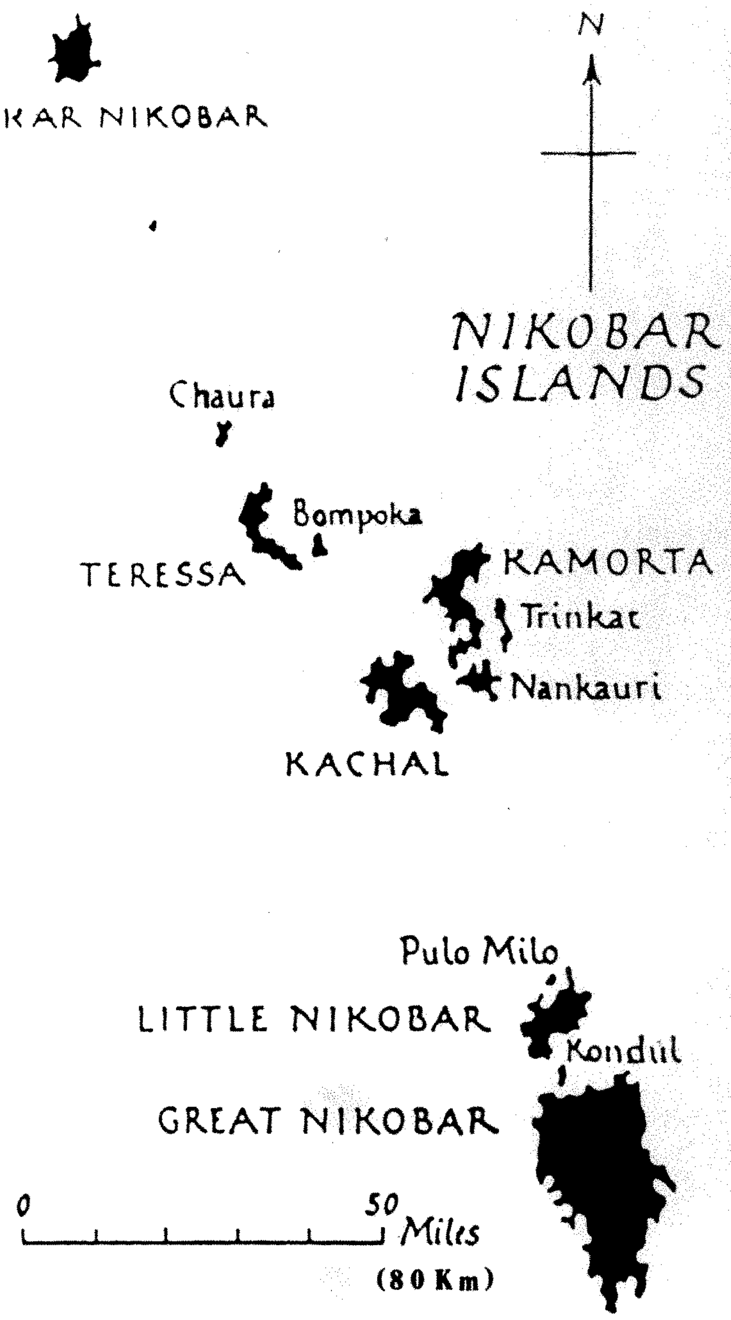

Fig. 2: Nicobar Islands

The forest-dwellers were less nomadic, for they undertook long journeys mostly in the dry season, when fruits and yams were plentiful, and it was possible to visit friends (Man 1883: 104; Radcliffe-Brown 1922: 31). This does not imply, however, that regular hunting and collecting expeditions into the forest were avoided during the rainy season. Moreover, as these groups generally inhabited more permanent structures, such as communal huts, they took care

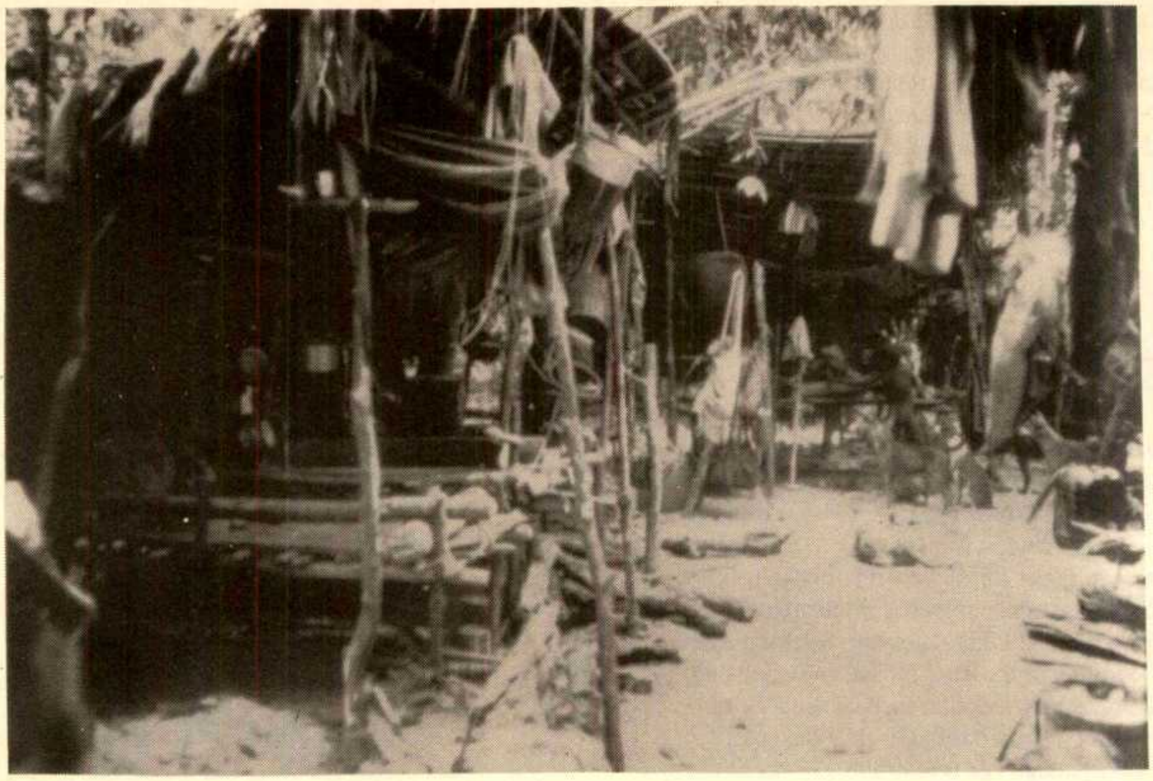

Fig. 3: Part of a temporary Onge encampment on Little Andaman Island

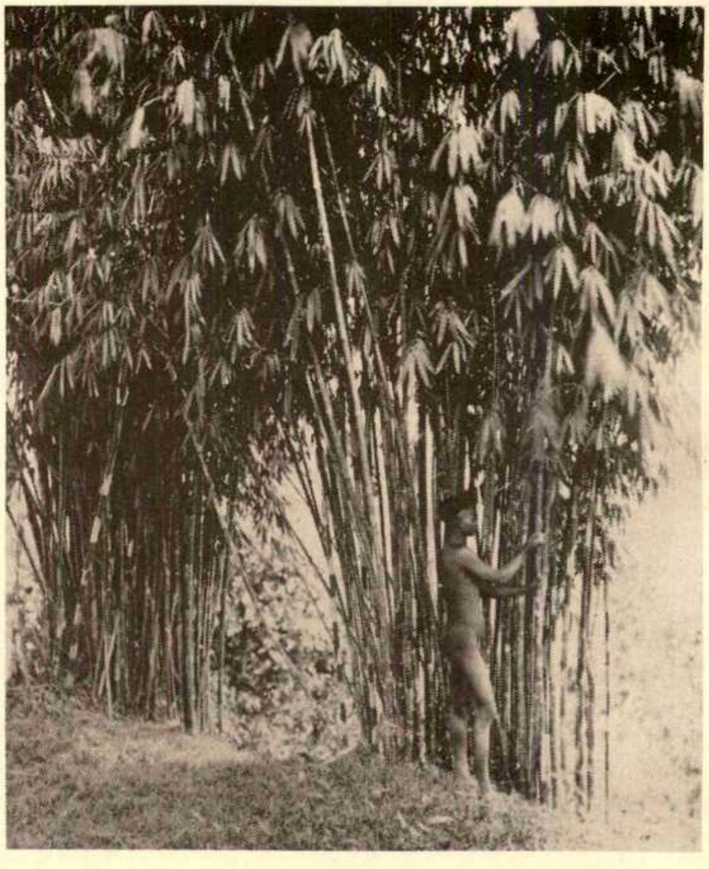

Fig. 4: Andamanese cutting bamboos for arrow shafts
(*Courtesy Museum of Mankind, London*)

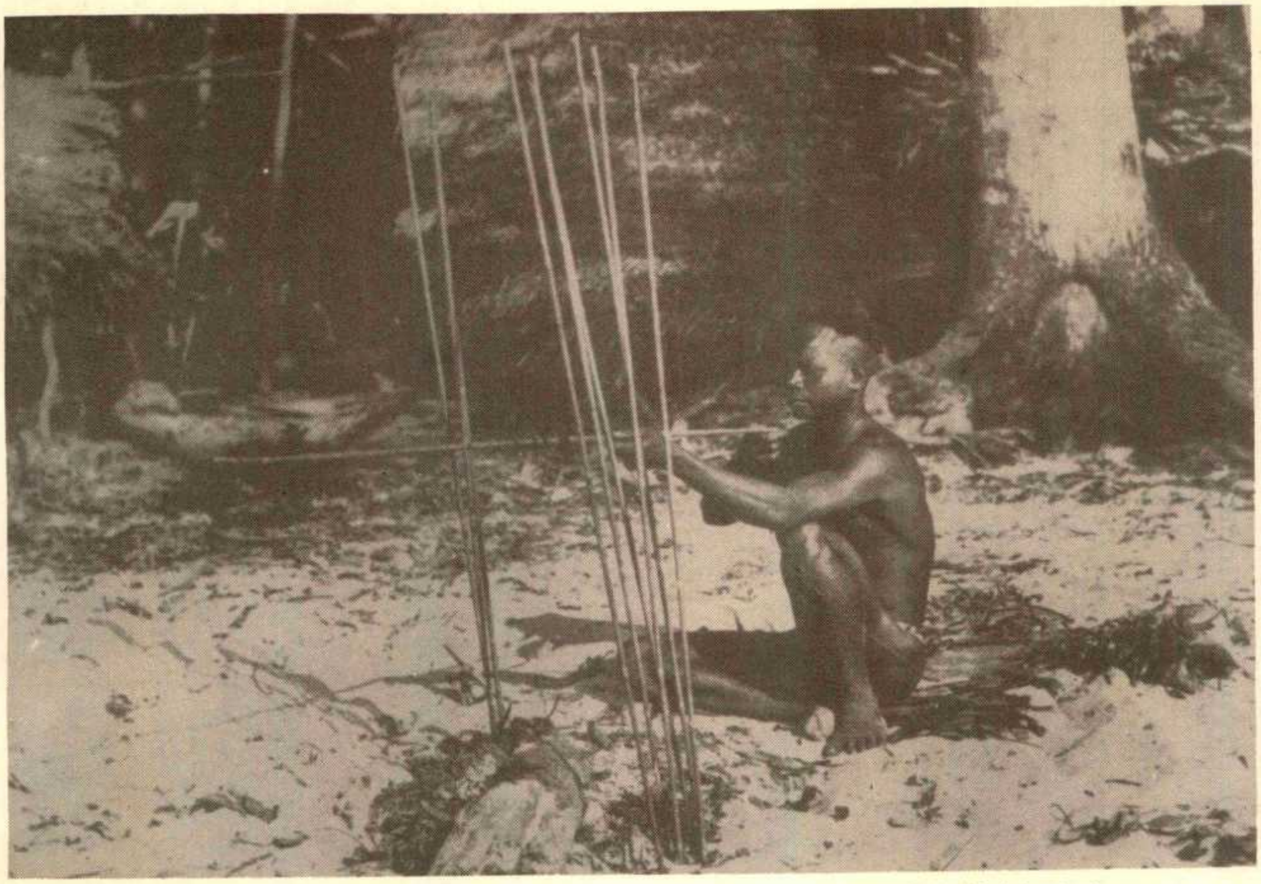

Fig. 5: Arrow shafts being heated over the fire and straightened by hand (*Courtesy Museum of Mankind, London*)

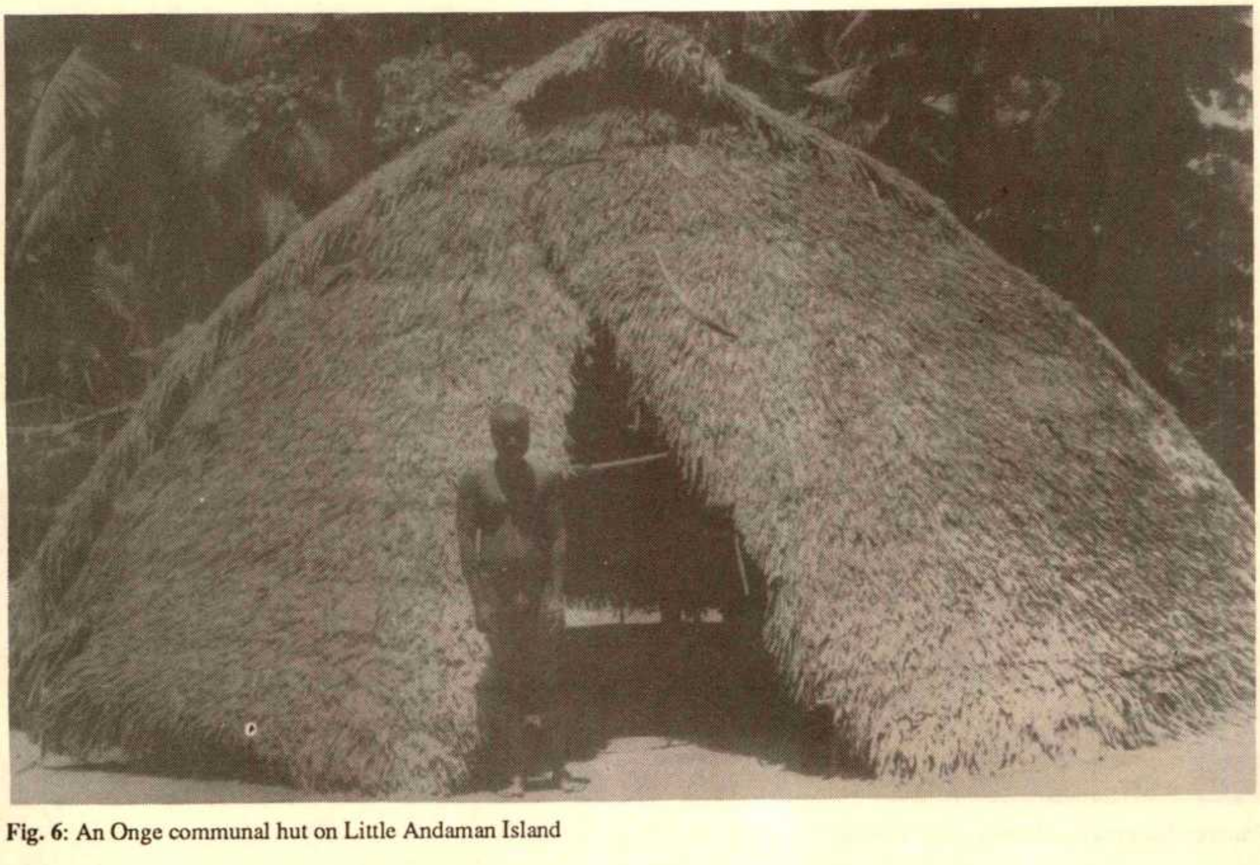

Fig. 6: An Onge communal hut on Little Andaman Island

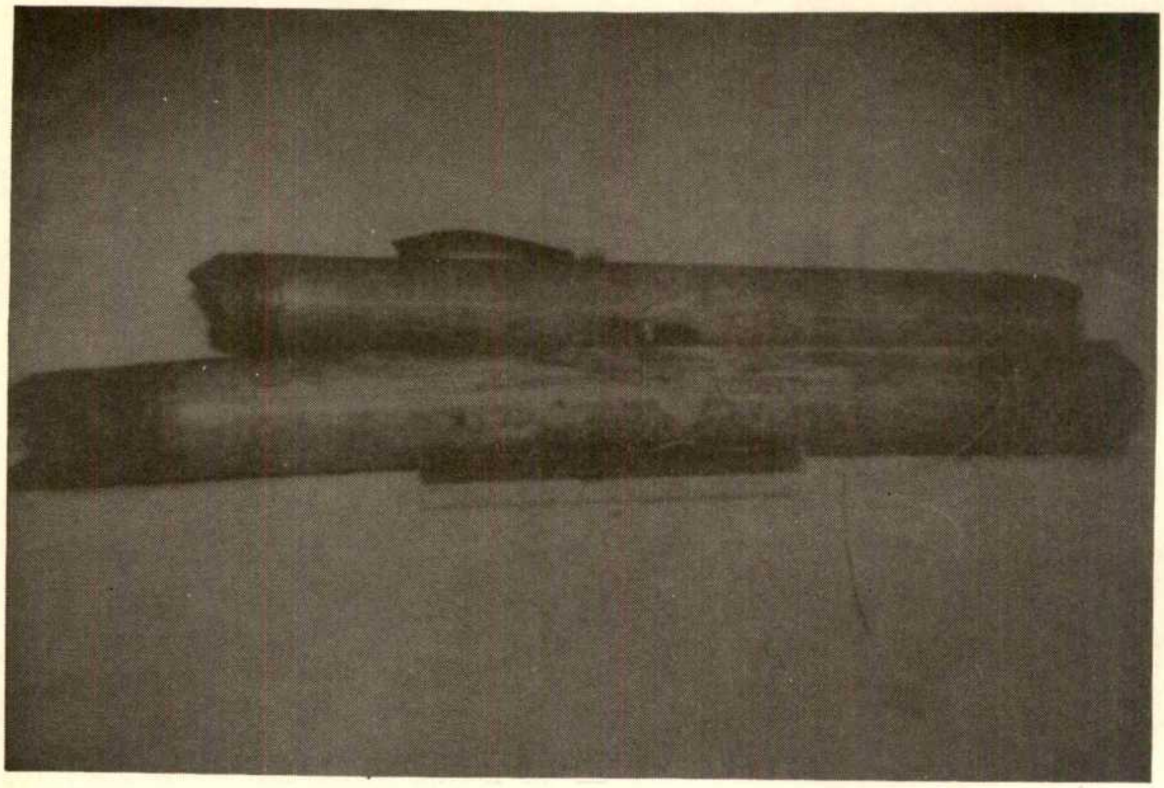

Fig. 7: Bamboo container in which half-cooked pieces of meat can be stored for several days

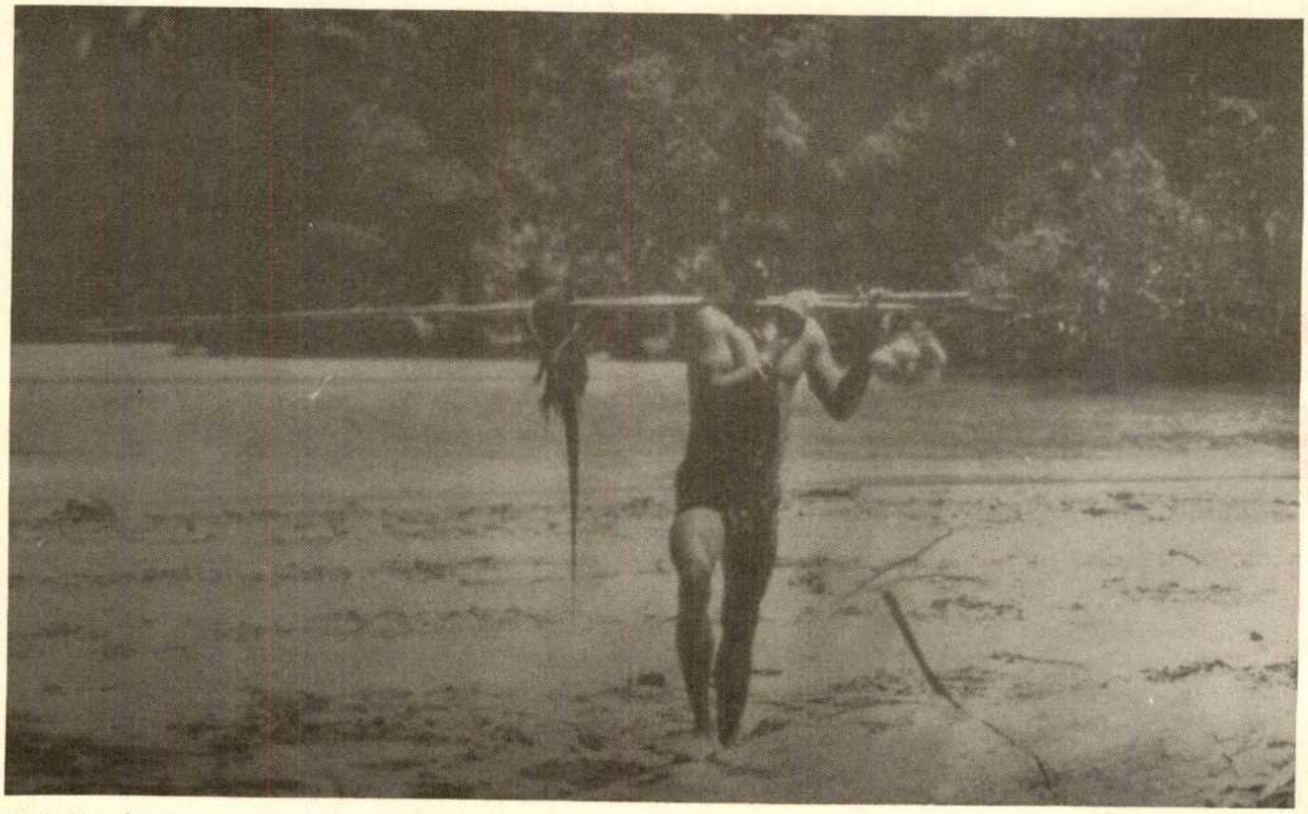

Fig. 8: Shompen hunter with a freshly killed monitor lizard and turtle eggs

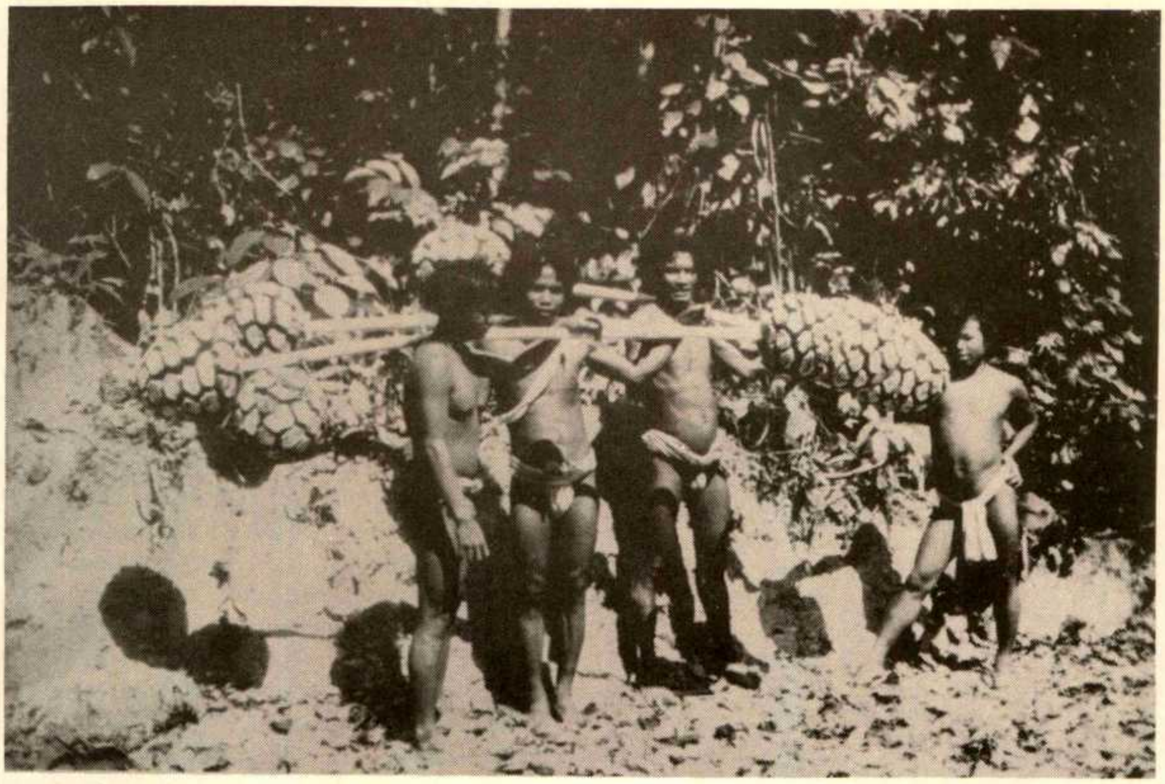

Fig. 9: Shompen men carrying pandanus fruit

to deposit refuse away from their camps in order to be free of offensive odours and to maintain a hygienic living environment (Man 1882: 281, 284). Fig. 6 shows an Onge communal hut on Little Andaman Island.

The relatively long-term occupation of camps within the forest can be attributed to the availability of ample sustenance during the year (Man 1883: 102). When viewed in this light, the inland population may be identified as 'collectors', while the mobility strategies of the coastal groups would approach the 'forager' model more closely. In this case, the former clearly outnumbered the latter.

Storage Practices among the Andaman Islanders

As the accretion of stores is a vital distinguishing factor between collectors and foragers, this subsistence strategy is examined with reference to its significance in the economy of the Andaman Islanders.

a) Pork and turtle meat could be kept for several days if half-cooked pieces were packed into a bamboo container (Fig. 7) which was heated slowly over the fire and then closed with leaves (Man 1883: 351).

b) Before the onset of the monsoon, the seeds of the jackfruit (*Artocarpus chaplasha*) were collected and buried in the ground for consumption during the rainy season (Man 1882: 282; Radcliffe-Brown 1922: 40).

c) One of the best foods of the Andaman Islanders was, the tuber of *Dioscorea glabra*, on which a taboo was imposed in the season of new growth in the belief that, Puluga, the being connected with the North-East monsoon, needed the yams at that season. A similar taboo protected the seed-crop of *Entada scandens* and the palm-cabbages of *Caryota sobolifera* (Radcliffe-Brown 1922: 152-3).

d) No attempt was made to domesticate any animals, although 'small pigs, if caught alive, were sometimes kept and fattened up for slaughter' (Man 1883: 349-50). This observation has been corroborated by Radcliffe-Brown (1922: 417).

Storage among the Andaman Islanders was, therefore, minimal. This was particularly so since jackfruit seeds did not constitute an indispensable item of food during the rains, when other terrestrial plant and animal resources were abundantly available. The ritual prohibition concerning the exploitation of certain yams and tubers, however, seems only a step away from the deliberate or accidental dispersal of seeds of valued fruit trees in the vicinity of camp sites, as practised by the Malaysian negritos (Hutterer 1983: 176). Similarly, the large stands of cycads in the southeastern part of Australia's Cape York Peninsula have resulted from 'the Aboriginal manipulation of the woodland ecosystem' (Harris 1977: 429). In the eastern Cape York Peninsula, on the other hand, wild yams could be harvested only with the permission of the head of the family or the clan in whose territory the yams grew (Harris 1977: 434). While none of these

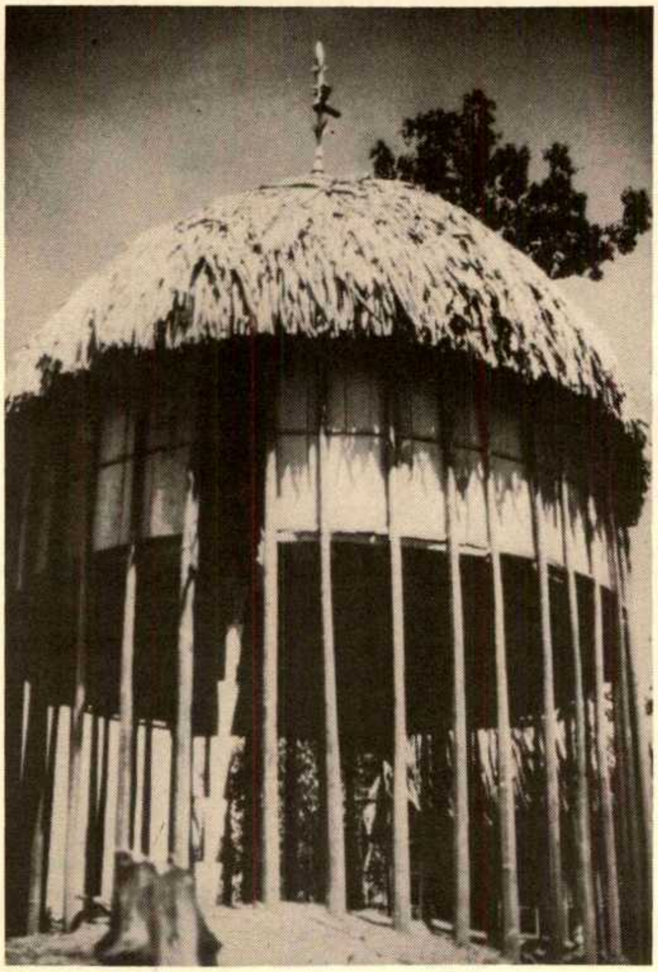

Fig. 10: Shompen hut

examples are illustrative of formal cultivation, they illumine various means of exercising partial control over the collection of important plant foods, thereby ensuring a steady supply of these resources. A similar strategy, albeit in the guise of ritual taboo, seems to have formed an integral part of the economy of the Andaman Islanders.

However, animal domestication *per se* can be ruled out, as young pigs, when caught occasionally, were killed for food and were not bred in captivitiy.

The Relevance of the Nicobarese Economy

An economy based on horticulture, such as that of the Nicobarese, may seem out of place in the forager/collector dichotomy, which is primarily concerned with contemporary hunting and gathering societies. However, the Nicobarese, including the Shompen, have been deliberately taken into consideration in this discussion, as the Nicobarese economy provides some interesting points of reference with similar features of the economic base in the Andamans. Here we have the marvellous opportunity of comparing the mechanism of storage, which operates at different levels of subsistence in a limited area (from north to south, the combined length of the Andaman and Nicobar Archipelagos is only 530 km, with only 120 km separating the islands of Little Andaman and Car Nicobar).

The Question of Isolation in the Bay of Bengal

The close proximity of these island chains has definite implications for the occurrence of subtle cultural interdigitation, an issue that is briefly discussed within the framework of the question of isolation and its significance in the development of local subsistence patterns.

Unlike the Andaman Islanders, the Nicobarese encouraged trade with neighbouring countries in Southeast Asia, and thereby remained within the sphere of maritime traffic in the Bay of Bengal. The relatively insular structure of Andamanese society probably restricted the need for regular trade relations with outsiders, though it was versatile enough to incorporate introductions such as canoes and pottery, similar to those of the Nicobarese, either through silent trade or through other means of communication (Cooper 1989). Another common feature in the cultural traditions of the Andamans and Nicobars involves the practice of preserving trophies of the skulls of pigs and turtles, though in different socio-religious contexts. In turn, these socio-economic trends would have been partly determined by the history of colonisation and settlement associated with each tribal group, as also by the degree of contact with regions that are peripheral to the Andaman and Nicobar Archipelagos, namely, Burma and Malaysia. Although there is no documentary evidence for a particular mode of exchange or, for that matter, any economic or social influences from an external source, it does not imply that the Andaman Islanders were completely isolated. In fact, as Sopher (1965: 360) has pointed out, external influences constitute only a minor criterion for 'successful cultural resistance'.

Salient Features of the Nicobarese Economic System

South of the Andamans lie the Nicobar Islands whose inhabitants are composed largely of Mongoloid stock comprising a mixture of Burmese and Malaysians. Their economy is based on horticulture and pig-herding, coconuts being the most important medium of barter in both inter-island and foreign trade. It is surprising to note, however, that no surplus of any kind is generated by the local economy (Justin 1990: 86). At most, it is considered necessary to ensure that there are enough coconuts for the pigs before selling the harvest (Justin 1990: 86)!

Contrary to most expectations, pig-herding does not yield any economic benefit, as these animals are valued principally for their meat which is consumed during feasts. The pig, in this context, is primarily a symbol of status and prestige. Of course, the animals that are bred for ceremonial purposes are given a special diet, while the others are allowed to forage in the forest. Hunting is confined to wild or feral pigs.

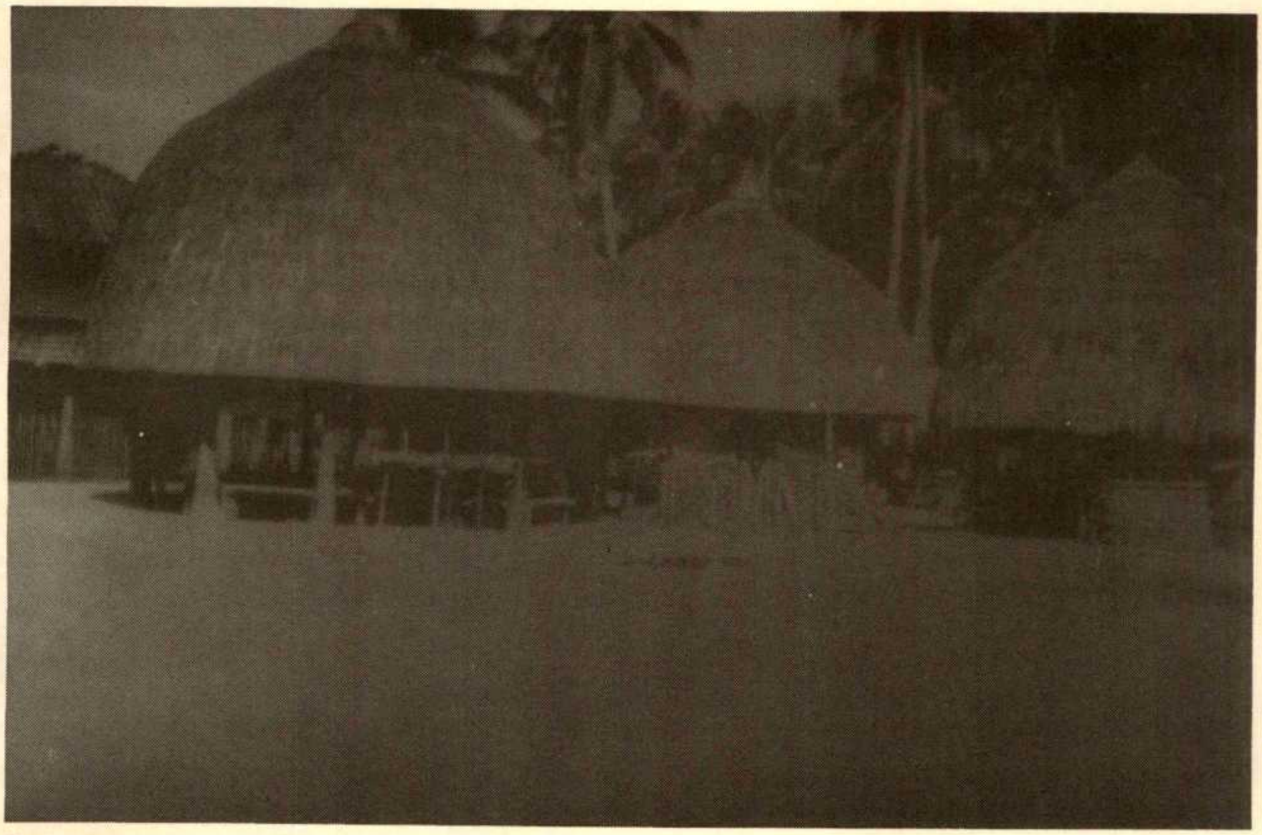

Fig. 11: Part of a Chowra village

One would expect that storage would play an important role in an horticultural economy, like that of the Nicobarese. But this is certainly not so acccording to Man (nd: 113-17) and the personal observations of the author, as mentioned below:

a) The *Pandanus leram* is an indispensable item of food. The paste made out of the farinaceous substance contained in the seeds can be stored for up to 3 months. In the dry season, however, the pandanus tree gives a poor yield of fruit, which has then to be substituted by rice.

b) Fresh pork (or wild pig), like fish, is cut into strips, salted, and dried in the sun for several days, after which it is kept in a jar covered with salt.

c) The fat of pork can be preserved for a month or more, and is added to pandanus paste as if it were butter.

d) In the islands of Teressa and Bompoka crabs are caught, fattened in cages, and let out when one is wanted for boiling.

These rudimentary means of storage demonstrate that the accretion of surplus is not an economic concern in the Nicobar Islands. This can be partially explained by the fact that coconuts, which constitute the principal items of trade, can be harvested at any time of the year, contingent on need, and freshly plucked nuts are always preferred. Moreover, the pandanus takes precedence over the coconut in the local diet. In addition, the pandanus is available throughout the year, except during the dry season, and is generally complemented by yams and other food crops.

The Shompen

Representing a subsistence level that is, in many ways, similar as well different from the ones outlined above, the Shompen of Great Nicobar Island are semi-nomadic forest-dwellers (Rizvi 1990). Their movements are regulated by the availability or otherwise of fruit and game (e.g. Fig. 8 shows a Shompen hunter with a freshly killed monitor lizard and turtle eggs). They subsist mainly on the fruit of *Pandanus leram* (Fig. 9), and are organised into bands which establish their camps near the groves of these trees (Fig. 10 illustrates a Shompen hut). They also practise horticulture on a small scale and are known to cultivate yams, pandanus, and a few other plants. Specific foraging activities are allocated to small task groups involving the members of a band who are rotated regularly. This allocation of variable 'effort-risk' foraging work ensures that the subsistence activities are shared equally by all band memebers. In the context of equal access to all the available food at a forest camp, this behaviour is seen as an off-setting mechanism to any claim of individual ownership of food resources. The undifferentiated seasonality of the Great Nicobar ecosystem acts as a catalyst to this foraging behaviour.

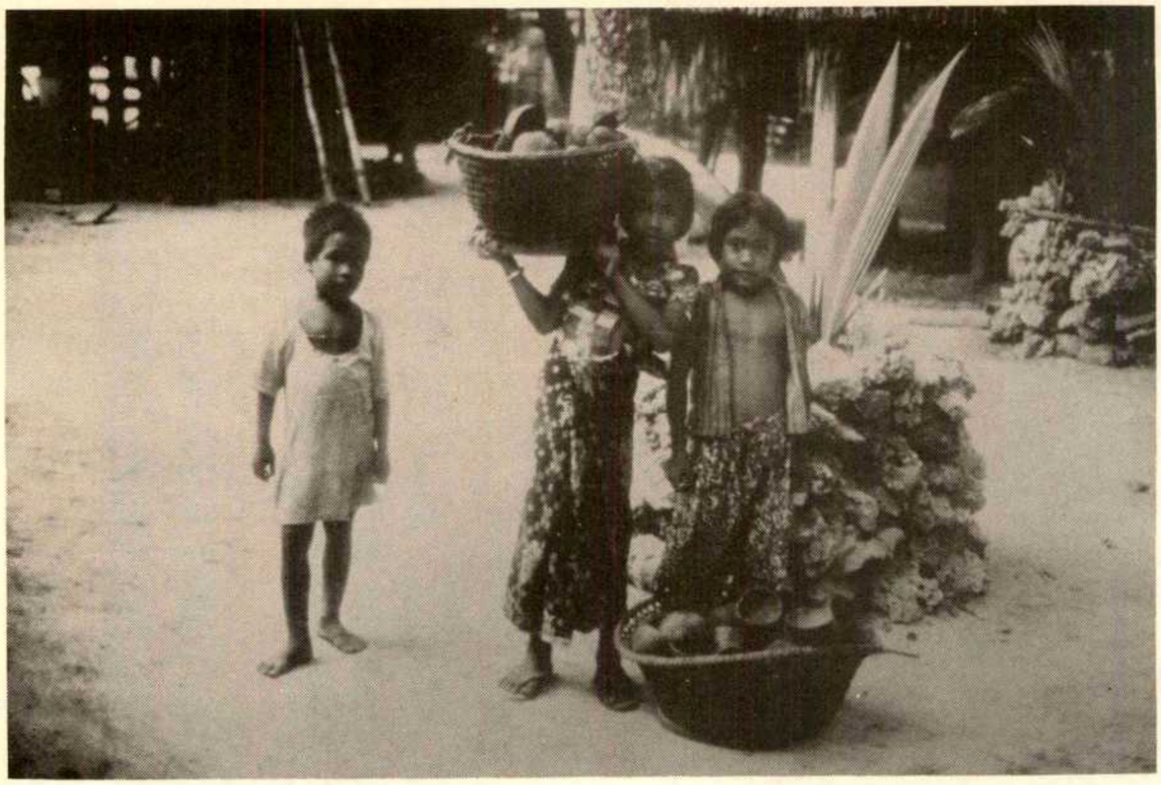

Fig. 12: Chowra children carrying baskets of coconut shells

In the case of the Shompen, therefore, we find that, in spite of incorporating primitive horticulture and limited food storage into their economic base, these forest-dwellers fit in well with the ecological model of 'least-effort' and 'least-risk'.

The Archaeological Implications of the Disposal Strategies in the Nicobar and Andaman Islands

Although the level of subsistence in the Nicobars differs from that in the Andamans, it is noteworthy that in the more densely populated islands of Car Nicobar and Chowra, villages are cleared of undergrowth, to remove all refuse and rubbish far away (Man, nd: 62). Moreover, dried coconut shells are burnt in the night so that adequate light is available, while the shells are efficiently disposed of. Fig. 11 shows part of a cleanly swept Chowra village, while in Fig. 12 one can see Chowra children carrying baskets of coconut shells.

In the relatively thinly populated central and southern groups of the Nicobar Islands, fewer sanitary precautions are observed, and litter, especially broken coconut shells, lies close to the huts. Moreover, care is not taken to bury the dead at a sufficient distance away from the villages, with the result that the natives suffer from various ailments (Man, nd: 62, 65). In the islands of Bompoka and Teressa, refuse is carried away in baskets and thrown on the foreshore (Man, nd: 65).

In light of the above, it is interesting to note that preliminary archaeological explorations carried out by the author in the Nicobars in 1989, yielded only a few midden-like deposits, particulary on the islands of Teressa and Chowra. In Great Nicobar island, an attempt to locate a Shompen encampment that had been abandoned for about a year proved even more difficult, for the regeneration of dense tropical vegetation had not only obliterated all traces of the site, but it was rendered virtually impenetrable on account of the thick undergrowth.

Further archaeological investigations would need to be undertaken in the Nicobars in order to ascertain whether the archaeological deposits in these islands are 'coarse-grained' (with poor resolution between archaeological remains and specific events), in keeping with low mobility, or 'fine-grained' as applicable to a high rate of mobility (Binford 1980: 17). This classificatory system is broadly relevant to the settlement pattern in the Andamans where shell middens are ubiquitous. The fact remains, however, that such deposits are associated with the mobile coast-dwellers as well as with the relatively sedentary inhabitants of the forests, although distances between sites vary (Cooper 1985). Another factor that complicates matters is that midden accumulations often served as platforms on which encampments could be estabilished. The implications of a mound serving a dual purpose, as it were, have been discussed elsewhere (Cooper, in press), though they render it difficult to adopt Binford's clear-cut distinction between assemblages, as mentioned above.

Concluding Remarks

A subsistence gradient, such as the one described above, within two contiguous archipelagos, is hardly amenable to the application of sharply defined categories of foragers and collectors, rather each of the three tribal groups mentioned above share features that are common to the two models proposed by Binford (1980).

Although a horticultural economy does not conform to these models, a consideration of the Nicobarese economic system, in conjunction with that of the Andaman Islanders, is amply justified in view of the opportunity it affords to assess the role of storage practices at different levels of subsistence, thereby placing the forager/collector dichotomy in a wider perspective. Moreover, taking into account the argument, as presented earlier, against the cultural isolation of the Andaman Islanders, any questions pertaining to their place among contemporaneous tribal groups, or to their origins, for that matter, would have to be investigated within a conceptual framework that recognizes their way of life as being integral to the economic network of the Bay of Bengal. It must be reiterated, however, that reciprocal involvement on the part of the Andaman Islanders, in a symbiotic or other relationship, is likely to have been minimal, considering their overall self-sufficiency, and the availability of greater freedom of choice in the past to adopt or reject ideas or innovations (Cooper 1989: 145).

Finally, it is interesting to see how the organizational variables that distinguish foragers and collectors have been defined by Woodburn (1980, 1982) in terms of 'immediate-return systems' and 'delayed-return systems'. The polarities involved in such a classification have recently been criticised by Bird-David (1992: 25), who points out that the economies of groups like the Australian aborigines combine strategies in which the return for labour is delayed and those in which it is immediate. In order to avoid polar types, therefore, Bird-David (1992: 25) posits 'a prototype immediate-return system and diverse (economic, social, idealogical) elaborations on it, especially on the theme of investment.'

As his example of the prototype immediate-return system, Bird-David (1992) cites the Nayaka of the Nilgiri-Wynaad in South India. This brings into sharper focus the current dilemma of defining the various tribal groups of South Asia. While Fox (1969) collectively identifies them as 'professional primitives', other scholars perceive them as marginal hunter-gatherers who have been compelled to retreat from their original territories in the face of agricultural encroachment, often seeking employment in cities in order to supplement their traditional subsistence activities (e.g. see Nagar and Misra 1989 and 1990 with reference to the Kanjars and other hunting-gathering communities in the Ganga Valley of Uttar Pradesh). On the other hand, many other groups, like the Birhor of the Chota Nagpur Plateau (Smiley 1979-80), the Hill Pandaram of Kerala (Morris 1982b), the Kanchapuri Yerukulas of South India (Murty 1981), and the Kuruk fishermen of Bastar District (Cooper 1986), combine hunting, food-gathering and fishing with contractual trade and barter. The Van Vagris, who are the hunters of the Thar Desert of Rajasthan, represent a unique case in having been discovered only recently (Misra 1990). The need to understand this broad spectrum of hunting and food-gathering economies in dynamic interaction with external influences and changing environments seems all the more urgent if the South Asian ethnographic record is to be interpreted correctly.

Acknowledgements

The author is grateful to the Indian Council of Historical Research for providing financial support for the research that has been undertaken for this paper. Figs. 4 and 5 are reproductions of the photographs that were taken by Mr. M.V. Portman in the last century, for which the author is indebted to Dr. Brian Durrans, Keeper, Museum of Mankind, London.

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Book Review

S. Settar, *Pursuing Death*, Institute of Indian Art History, Karnatak University, Dharwad, 1990, Price: Rs. 325/-.

It was exactly a decade ago in 1982 that Professor Settar, in association with the late Professor G.D. Sontheimer, brought out an aesthetically handsome and academically very rich volume entitled *Memorial Stones*. This was perhaps the beginning of his interest in religious responses to human beings' perennial anxiety about death. With the publication of *Inviting Death* in 1986 and now *Pursuing Death*, Settar not only presents ample evidence of his interest growing into a passion for further study of *ars moriendi* (the art of dying), but has also opened up a new vista of inquiry.

Some studies abroad, particularly of the French, have focussed on the so-called 'Christianization' of Death during the end of the Middle Ages (c. A.D. 1350-1500) in western Europe. However, two related observations need to be made in the context of Settar's works which provide greater lucidity to his perspective:

(a) unlike the European studies, Settar's Karnataka scenario takes us considerably further back chronologically — his evidence begins in the sixth/seventh centuries and mounts enormously between the tenth and fourteenth centuries, and

(b) unlike Nider's *Dispositorium moriendi* and Gerson's *Opusculum tripartitum* and other manuscripts on the art of dying, which show a limited visual pedagogy. Setter's plethora of epigraphic, literary and sculptural/monumental data amassed even from a small geographical area is not only bewildering but also creates an aura of the gigantic proportions of the extant but untapped resources.

Inviting Death, while attempting to trace the history of ritual death confined itself to the epigraphic material found at Sravana Belgola. Its sequel *Pursuing Death* seeks to relate the theory and practice of the voluntary termination of life. It visualizes for us the philosophy of death through formidable textual material embodied in (i) canonical Jaina texts in Prakrit and Sanskrit and (ii) classical Jaina *Kavya* literature in Kannada (10th-14th/15th centuries), on which the author has already compiled a *Subject Index* (unpublished till date) in as many as thirty-two volumes (see bibliography, pp. 369-371). This material has also been vividly supplemented and corroborated by copious epigraphic references and archaeological remains. Evidently, this exercise enabled the author to expand the geographical confines from a small religious centre — Sravana Belgola — to the 'less-sacred' and 'non-sacred' centres of the lower Deccan as well as to remind us of the geographical spread and routes of dispersal of the west European manuscripts on the Art of Dying.

The Jaina canonical texts and more particularly the aforesaid *Kavya* literature in Kannada introduce us to as many as forty-eight types of death (very cogently presented in a tabular form, pp. 10-11). Professor Settar is not daunted by this bewildering variety. He rightly contends that these were not inter- changeable alternatives and that each of these terms signified a distinct element in the path of pursuit. Lest one gets bored with dreary technical minutae and descriptive details of these terms (e.g., nearly eight pages of *sallekhana* of Panduraja, pp. 191-198), the author keeps the interest of the reader alive by situating these practices in their material setting. We are, for instance, enlightened about:

(a) the social bases of *sanyasana* (pp. 251f): which remained confined largely to the aristocracy comprising the ruling class and the prosperous mercantile community — victims of the *karmic* wheel such as the poor wood-cutter Kittayya being a rare exception. The *sanyasana* was accessible to all those who were entitled to undergo the *upanayana* with the exception of *visvakarmins* (specially artisans and craftsmen);

(b) the impact of the transition from pastoralism to agriculture, illustrated through the careful study of the early twelfth century scene at Avali (pp. 282-84);

(c) correlations between ritual death and shifting religious patronage (pp. 284-85);

(d) dispersal of the practice from the prestigious religious centres such as Sravana Belgola and Koppal to rural centres in the eleventh century (pp. 271-72);

(e) contributions made by the inconspicuous and less conspicuous members of the society, e.g. all *sanyasana* deaths (10) between c. A.D. 600 and 900 were by monks and nuns but in the five subsequent centuries (A.D. 901-1400) as many as eight out of a total of twelve deaths of this type were pursued by laymen and lay-women (pp. 269-71). Similiarly, the distribution of the *sallekhana* practice amongst monks, laymen and lay-women was in the ratio of 8:2:1 (p. 204);

(f) periods and areas of concentration: more than 50% of the *sanyasana* deaths during the 14th century were confined to the Sorab taluk of the Shimoga district and spread to the coastal areas in the late 14th and early 15th centuries (p. 277). Similarly, data have been tabulated about the regional distribution of *samadhi*, configuration of deaths identified with a combination of terms and concentration of *samadhi* deaths by laymen and lay-women in the Tungabhadra region (pp. 130-39). (See also details of *sallekhana* on pp. 198-201 and *aradhana* on pp. 235-242);

(g) chronological and sex-wise incidence (pp. 288f): there being one death in about every two to two and a half years between A.D. 1346 and 1403, and women outnumbering men between 1383 and 1403;

(h) fascinating history of a single Hire Avali 'Family that Loved Death'. Taking to ritual deaths as eagerly and heroically as other warriors of their time were taking to the battlefield to gain prosperity, the chieftains of Hire Avali distinguished themselves in the history of Jainism between the twelfth and fifteenth centuries. This shrewd Jaina family had risen to claim the position of *nalprabhus*. Imagine, this was achieved in the midst of multi-sided attacks on the Jains, particularly by the Virasaivas in the 13th century (pp. 149-51, 273-85);

(i) places which were considered uncongenial for pursuing death through *samadhi* (the most popular term for the voluntary termination of life in the lower Deccan) (p. 115): these included those which were frequented by women, eunuchs, gamblers, drunkards, animals, wicked rulers and religious extremists such as the Kaulas and Kapalikas, and finally

(j) justifiable occasions for undertaking ritual death (pp. 26, 146-148, 183-84 and 246-50) — Tammegauda, who was suffering from tuberculosis at Jambehalli (Shimoga district), died meditating on the *pancapadas* (p. 174).

In addition to the aforesaid multi-faceted presentation, a comprehensive bibliography and no less exhaustive glossary (about 1100 terms) accompanied with 112 charcoal prints make *Pursuing Death* a work of great dedication.

Though a little editing could have enabled the author to eliminate avoidable repetitions and make it a tighter text, this does not undermine the seminal contribution made by Professor Settar. Treading along an unchartered field, he has been extremely judicious in pursuing a truly multi-disciplinary approach towards man's great anxiety about and also fear of (not for the Jains, it seems) death.

Pursuing Death is new and a work of awesome and inspiring scholarship.

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Book Review

Adaptation and Other Essays, edited by N.C. Ghosh and S. Chakrabarti. Published by Research Publications, Visva Bharati, Santiniketan. Pages 334. Price Rs. 150.

Adaptation and Other Essays is a volume containing papers presented at the Annual Meeting of three societies, namely the Indian Archaeological Society, the Indian Society for Prehistoric and Quaternary Studies and the Indian History and Culture Society which were hosted by Visva Bharati, Santiniketan in December 1989. The themes chosen for discussion were 'Recent Discoveries in Proto and Early Historical Periods', 'Cultural Adaptation of Hunter-Gatherers in the Holocene' and 'Indian culture and civilization,' respectively for the three Societies. These themes are broad-based rather than problem-oriented. The consequent diversity in the contents of the volume have compelled the editors to club some of the papers under the convenient hold — all term 'adaptation', and the rest under 'other essays '. The volume contains 36 papers divided into seven parts.

Part I consists of three presidential addresses that were delivered by the late Vishnu-Mittre, S.R. Rao and R.C. Gaur, respectively. The addresses could have benefited from some editing and careful proof-reading. In his address the late Vishnu Mittre offers a comprehensive review of 40 years of archaeobotanical research in India, which is followed by a plea to archaeobotanists to use modern comparative data bases critically and without overlooking new developments in plant taxonomy. He urges the archaeologist to use modern methods for recovering palaeo/archaeobotanical remains and calls for the development of a modern comparative database. S.R. Rao's address entitled, 'New Light on the Dark Age of Indian History', seeks to throw light on the period between the end of the Indus Civilization and the Buddhist period by using literary evidence from ancient texts and by applying the latest scientific research methods. The Marine Archaeology Project at Dwarka also attempts to elucidate the Dark Age. The address by R.C. Gaur is an account of the excavations at Fatehpur Sikri with special reference to the correlation between the existing structures and contemporary textual descriptions and paintings.

Part II is entitled 'The Quaternary Environment and Culture' and contains four papers. The first one by V.N. Misra *et al.* deals with formation processes at the prehistoric site of Samnapur in Madhya Pradesh, the Quaternary geological history of the Narmada and its palaeontological record. The paper by R.P. Pandey on the late Quaternary fossils and Middle Palaeolithic sites in the Parvati Valley in Madhya Pradesh is just another addition to the growing plethora of data on the Palaeolithic record of India. Badam and Sathe review the evidence for the ostrich in India with reference to the behavioral biology and taxonomy, the palaeogeographic distribution and its dietary role in the Upper Palaeolithic period.

Part III comprises 11 papers on cultural adaptations during the Holocene. Corvinus and T.C. Sharma find Hoabinhian affinities in the artifacts they recovered from eastern Nepal, and Rongram valley in the Garo hills, respectively. Such evidence has been tentatively taken as being indicative of the migration of prehistoric populations from Southeast Asia into the Indian subcontinent via Burma and Assam.

The papers by Malti Nagar, M. Bhattacharya, as well as D. Chaudhari and A. Ghosh, typify the current trends in ethnoarchaeological research in India. M. Nagar makes a direct historical analogy between the nomadic Kanjar groups of Uttar Pradesh and Mesolithic hunter-gatherers. Bhattacharya attempts to reconstruct the Holocene cultures of the area around Darjeerling through a study of the adaptation patterns of the local Lepchas population whose environment is presumably similar to that in the past. Such analogies certainly go a long way in providing insights about the past. However, it must be realised that cultural response to certain environmental stimuli may vary over a period of time, given the dynamism inherent in the process of adaptation. Chaudhuri and Ghosh draw parallels between present-day demographic patterns of the Kharias (marginal hunters) and Santals (agriculturists). The authors try to absolve themselves of any criticism by pointing out the limitations of such analogies. However, they argue that the regular population pyramid of the Santal population and the irregular one of the Kharias demonstrates how a change in food resources is a determinant for population dynamics. Underlying this is the assumption that hunting-gathering reflects uncertainty in food supply, while a settled agricultural economy spells stability in food supply. Such a view is purely conjectural, as it neglects to examine the mechanisms by which populations respond to different modes of subsistence. The paper by Chattopadhyay and Chattopadhyay, on the evidence for spatial organisation of the mortuary practices in the Mesolithic sites of the Ganga plains, is an interesting attempt to understand the seasonality, territoriality and cultural adaptation of the Ganga Plain dwellers in relation to their contemporaries in the Vindhyan region. Section III also includes studies on archaeobotanical remains, ethnobotany and rock art.

Part IV consists of papers on the protohistory of Northern India, especially the Ganga Plains. It presents brief excavation reports on the Harappan site of Nagwada in Gujarat, Thanesar in Haryana and Jakhera in Uttar Pradresh. Also included are reports on protohistoric investigations in Pratapgarh district, Uttar Pradesh, by V.D. Sharma, the western fringe of the Bengal delta by N.C. Ghosh and S. Chakrabarti, and at Manjhi in district Saran of Bihar by T.N. Roy. J.N. Pal investigates the interrelationship of the Chalcolithic cultures of the Ganga plains and the Vindhyan region. A careful analysis of these papers reveals a culture-historical approach to the past. The need to understand culture change is articulated by all, but is always explained by invoking external factors such as the migration of new population groups/ideas, or environmental change. Sometimes deviations from cultural norms are interpreted as regional innovations and left at that. The studies mostly concentrate on establishing cultural continuities, discontinuities or affinities, especially in the ceramic traditions. In order to overcome the limitation of such traditions, the archaeological record needs to be understood in its entirety and the internal dynamics of a system need to be looked into as well. This would help to determine the factors involved in the process of culture change.

The paper by Jamal Siddiqui (only one in Part V) very lucidly points out what ails medieval archaeology in India. He comments on how medieval archaeologists mostly concentrate on setting the historical records straight by trying to find structures and places mentioned in the historical texts. Another malaise affecting this branch of history is its emphasis on studying the nobility and not the common masses. There is a fascination for excavating monuments, elaborate structures and palatial buildings. I, however, disagree with Jamal Siddiqui's dismissal of surface survey as being peripheral. Considering the lack of funds and resources which besiege most archaeology departments in India, it is perhaps the need of the hour to emphasize the importance of the surficial archaeological record. An intensive, problem-oriented surface survey can go a long way in answering questions about the past, especially if one desires to reconstruct the history of the common people. One such example in medieval archaeology is that of the Vijaynagar Metropolitan Survey undertaken by the University of California, Berkeley and the State Department of Archaeology, Karnataka.

Part VI entitled 'Science and Archaeology' contains wide-ranging papers including an analysis of the Indus script, tree-ring dating of old timber and conifers for determining the drought history of India, analyses of issues regarding the diffusion of the knowledge of iron technology in Eastern India and the study of stone anchors as sources of information on ancient maritime communities.

The final part (Part VII) deals with papers on history and culture. It is in this section that the lack of thematic unity is most evident. The topics range from the origin of the Swastika to the call for the convergence of world civilizations. The section also includes papers on the terracotta art of Birbhum, non-elitist occupational caste groups in Bengal and the marriage of the cosmic couple Siva and Parvati.

On the whole this book gives the reader a good idea of the various subjects being addressed by Indian Archaeology and the current trends in methodology and theory. However, its is clear that our conceptual foundations and research strategies need to be re-evaluated, in addition to the theoretical base on which our knowledge of the past rests.

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Report on the 3rd International Congress on Human Palaeontology, Jerusalem, Israel

The 3rd International Congress on Human Palaeontology organised by the International Association for the study of Human Palaeontology, was held in Jerusalem, Israel from 23rd to 28th August 1992. The Organising Secretary of this Congress was Professor Patricia Smith (Hebrew University, Jerusalem). The Congress is held every five years and the next is to be held in South Africa in 1997. The Jerusalem meeting was the first Human Palaeontology Congress to be held outside of Europe. In choosing Israel as the venue, one of the main considerations was its importance for the study of human evolution, evidences for which have been recovered in abundance from various cave sites in Israel.

Over 225 delegates from nearly 30 countries participated in the Congress. Dr. G.L. Badam was the sole representative from India. He presented his paper on "Pleistocene Climatic Changes, Mammalian Faunas and the Fossil Man of India" in the Plenary session ("Subsistence, Technology and Palaeoecology in the Pleistocene"). A total of about 140 papers were presented divided into the following themes.

1. Ancestors of humankind (6 papers)
2. Franz Weidenreich: His contribution to Palaeoanthropology (11 papers)
3. Australopithecines and their background (9 papers)
4. New fossil discoveries (8 papers)
5. Morphometric variation and functional adaptations in fossil hominids and hominoids (20 papers)
6. *Homo erectus* and the ante-Neanderthal (3 papers)
7. Evolutionary trends in the genus *Homo* (17 papers)
8. Direct dating of palaeolithic sites (3 papers)
9. Neanderthals and the origin of modern humans (8 papers)
10. Subsistence, technology and palaeoecology in the Pleistocene (8 papers)
11. Population variation from the Upper Palaeolithic to the Neolithic (15 papers)
12. Dental development in fossils (8 papers)
13. Growth and development in fossil hominids (5 papers)
14. New development in DNA analysis of fossils (5 papers)
15. Hominids and hunting in the Middle and Upper Palaeolithic (5 papers)
16. The archaeology of Upper Palaeolithic to Neolithic populations (5 papers)

There were also well represented poster sessions related to 22 topics such as archaeozoology, the histological structure of bones, Ubeidiya, biomolecular and palaeontological data on primate phylogeny, taphonomy and damage patterns in early Hominids from Israel, language origins, ontogenetic development on the skulls of modern humans, subsistence and health, funeral rites, palaeodietary study, mammals and lithic remains, Neanderthal teeth, etc.

A workshop dealing with the relationship of fossils excavated in Israel with those found elsewhere and their relevance to human evolution and development was also held as part of the Congress.

The Congress started with the opening ceremony on the morning of the 24th August. The President of the Congress, Professor H. De Lumley inaugurated it, while Professor Y. Birk, Pro-Rector of the Hebrew University gave the welcome speech. Some interesting papers under the plenary session ("The Ancestors of Humankind") included those on the palaeoecological background to the transition from *Australopithecus* to *Homo*, taxonomic affinities of the SK 847 cranium from Swartkrans, the origin and relationship of early Homo, etc. One half-day session was devoted to the contribution of Franz Weidenreich to palaeoanthropology. Other important papers included isotopic analysis of Plio-Pleistocene fauna from Swartkrans, early *Homo sapiens* in China, hominid fossils as seen through the filter of Natural Selection, cranium remains from Germany, human discoveries from Java, CT-Scanning and 3-D imaging of hominid fossils, Hominid Body Mass prediction, Cro-Magnon Man, evolutionary trends in *Homo*, data on fossil men in Russia, dating of Palaeolithic sites, ESR dating of hominid sites in Israel, human remains from Portugal, migration of mammals, and a host of other topics which brought out several new techniques being applied to the study of fossils in general and human fossils in particular.

It was observed that during the last four years since the Turin meeting, much progress had been made in the study of human palaeontology. Many new fossils were discovered with the application of new dating techniques, which enabled scientists to date them and the older finds much more accurately than had been done before. Isotopic studies, imaging techniques and DNA analyses are now providing increasingly detailed information on the diet, genetics and biomechanical efficiency of past populations. It was also noted that the political changes of the past four years have led to greater freedom of movement and communication between researchers in different countries and this has opened up new avenues for collaborative research. At the same time the pace of slaughter, famine and destruction both of people and their environment that is now also proceeding apace provided a sobering commentary to our discussion of long term evolutionary trends in human populations. Professor Patricia Smith expressed the hope that by the next congress we would meet not only to discuss new research developments but also to celebrate progress for humanity in general.

Apart from the very successful sessions which continued sometimes even upto 19 hours, there were several pre-, in-, and post-Congress tour programmes.

The pre-Congress field tours (20th to 22nd August) included visits to Bedouin Museumat Lahav which documents traditional Bedouin life in the Negev and Sinai. Some natural springs in the Canyon of Nahal and also important prehistoric sites in its vicinity (Rosh Ein Mor — Mousterian; Boker Tachtit — transitional Middle to Upper Palaeolithic; Boker — Upper Palaeolithic; Nahal Divshon — Neolithic) were visited. An interesting visit was made to the "King Solomons Mines" to see the main shafts, processing and habitation associated with the beginning of metallurgy. A visit was arranged to Masada, the site of the last stand of the Jews in their revolt against Rome and also the Ein Gedi, an oasis located in the Judean desert adjacent to the Dead Sea.

The post-Congress field trips (29th to 31st August) included visits to the Neolithic sites of Jericho, Netiv-Hagdoud and Shaar Hagolan, the Lower Pleistocene site of Ubeidiya, the Upper Palaeolithic site of Ohalo, the important Upper Pleistocene cave sites of Amoud and Zouttiyeh, the Natufian site of Einan, the Bronze Age Tel of Hazor and the Upper Pleistocene site of Qafzeh.

The in-Congress field programme included visits to some of the major prehistoric sites in the Carmel Caves on the 26th August, where participants were able to inspect sites and discuss their interpretations with the prehistorians involved in the excavations. The caves visited were the Skhul, Tabun, El Wad, Kebara, etc. all of which have yielded excellent evidence of the Stone Age of the Near East. Most of these sites are published but some new data will be in print soon. Explanations to these excavations were given by A. Ronen, O. Bar-Yosef, Y. Rak, D. Kaufman, E. Tchernov and others working on the caves. Most of the above scholars and J. Perrot, D. Nadel, A. Gopher, F. Valla, E. Hovers and others were the scientific consultants also in the pre- and post-Congress field trips. Maps and section drawings of the sites were distributed amongst the participants for convenience. After the trip participants had lunch by the Mediterranean and those wishing to swim had an opportunity to do so. On our way back we also visited a Nautical Archaeology Centre by the shore and saw the various antiquities (including grains and bones) retrieved by scholars and dated to the Historical period. On the whole it was extremely exciting to be able to see some of the most important archaeological sites in the Near East about which we had read and heard so much. These visits were the most important items of the Human Palaeontology meetings.

On the whole the Congress offered a unique opportunity to meet colleagues as well as to combine the exchange of scientific knowledge with the memorable experience of visiting Israel.

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